TRAUMATIC BRAIN INJURIES IN MASSACHUSETTS: 1995-2000

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June 2004

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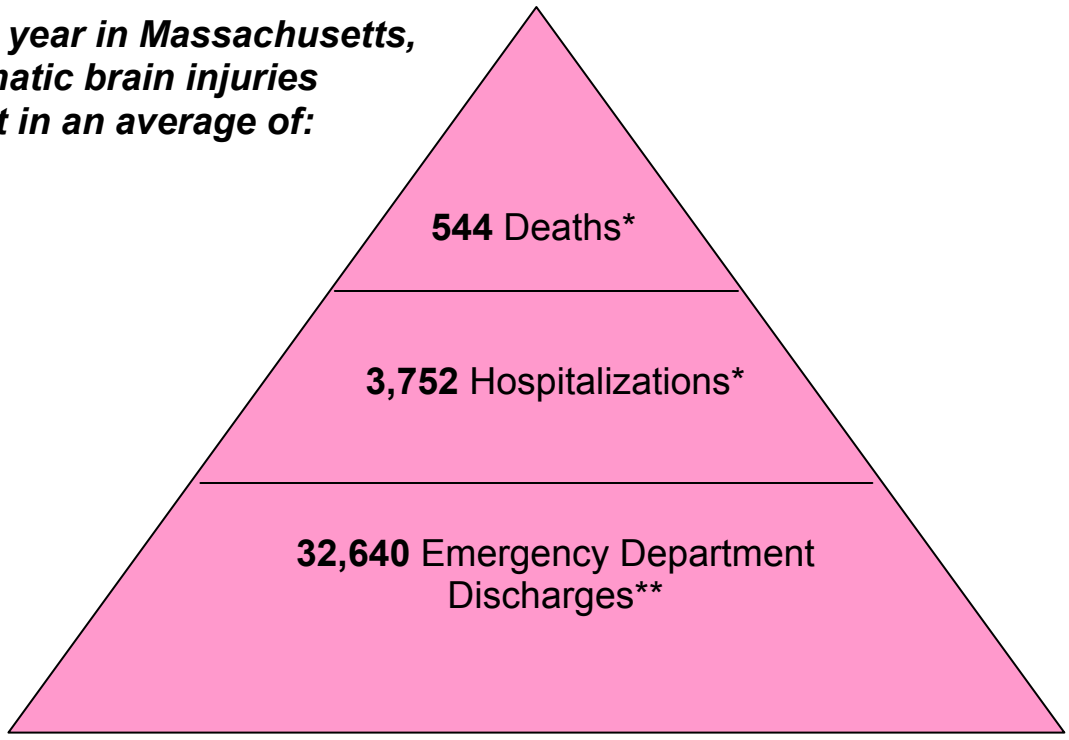
Each year in Massachusetts, traumatic brain injuries result in an average of:



* Based on average annual numbers, 1995-2000; hospital discharges are non-fatal.
** 2002 non-fatal emergency department discharges.

Massachusetts Department of Public Health
Center for Health Information, Statistics, Research and Evaluation
Injury Surveillance Program

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For information on how to prevent injuries, contact Cindy Rodgers at the Injury Prevention and Control Program (617-624-5413), or on-line at:
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EXECUTIVE SUMMARY

Traumatic brain injuries[1] (TBI) are an important public health problem in Massachusetts and across the nation. Each year, an estimated 1.5 million individuals in the U.S. sustain a TBI.[2] This represents eight times the number of people diagnosed with breast cancer and thirty-four times the number of new cases of HIV/AIDS.[3] Compared with other types of injury, brain injuries are among the most likely to cause death or permanent disability. Nationwide, approximately 50,000 of those sustaining a TBI will die of their injury, and another 80,000-90,000 experience the onset of long-term or lifelong disability.[4]

The majority of individuals who sustain moderate/severe traumatic brain injury (TBI) experience significant physical, behavioral/psychiatric, psychosocial, cognitive, and medical problems. These health problems negatively impact functional independence, community access and living skills, vocational outcomes, and psychosocial development, and may extend throughout a lifetime. Research has shown that TBI can contribute to increase in high school dropout rates, unemployment, risk for substance abuse, psychiatric hospitalizations including suicide attempts, and criminal activity.[5] Injured individuals can benefit from (and often require) specialized services and supports to improve their health overall and increase their levels of independence and functioning.

An estimated one in every 170 Massachusetts residents experiences a TBI severe enough to result in death, hospital admission or emergency department treatment each year. In 2000, there were 551 TBI fatalities and another 3,965 TBI-related hospitalizations among Massachusetts residents. Further, based on 2002 data, there are another 32,640 emergency department visits annually in Massachusetts for this injury. For every person who dies from a TBI, an estimated seven people survive to be discharged from an acute care hospital and an estimated seventy are treated and released from emergency departments. Falls became the leading cause of TBI-related fatalities in 1999, surpassing firearm-related TBI fatalities. Falls were also the leading cause of non-fatal TBI-related hospital discharges from 1995 through 2000. The total charges for TBI-related hospitalizations in 2000 for Massachusetts state residents was over $102 million. More than half of these charges were paid through public sources.

[1] A TBI is defined as an occurrence of injury to the head (arising from blunt or penetrating trauma or from acceleration-deceleration forces) that is associated with any of these symptoms or signs attributable to the injury: decreased level of consciousness, amnesia, other neurologic or neuropsychologic abnormalities, skull fracture, diagnosed intracranial lesions, or death. Exclusions include: 1) lacerations or contusions limited to the eye, ear, face or scalp; 2) birth trauma; 3) primary anoxic, inflammatory, infectious, toxic, or metabolic encephalopathies that are not complications of head trauma; 4) tumors; and 5) brain infarction (ischemic stroke) and intracranial hemorrhage (hemorrhagic stroke) without associated trauma.[State and Territorial Injury Prevention Directors Association (STIPDA). *Council of State and Territorial Epidemiologists Injury Indicators for Surveillance*;1999. www.stipda.org/resol/99nphss-tbi.htm].

[2] CDC, National Center for Injury Prevention and Control (NCIPC). Traumatic Brain Injury Fact Sheet; Accessed December 2003. www.cdc.gov/ncipc/factsheets/tbi.htm www.cdc.gov/ncipc/factsheets/tbi.htm.

[3] ibid.

[4] ibid.

[5] LaVecchia F. *Final Report of the Massachusetts Traumatic Brain Injury Transition Project,* June, 1996

Most traumatic brain injuries are preventable. Injury prevention efforts, including those directed toward prevention of TBIs, are often grouped into three major areas: education, enactment and enforcement of laws, and environmental modification or engineering. Because the sequence of events leading up to these injuries frequently follows a predictable pattern, knowing the causes and circumstances behind these injuries can assist groups around the state in developing effective prevention strategies. Many proven strategies to prevent TBIs exist (see Appendix A); the challenge is to implement them.

This report provides an updated overview of fatal and non-fatal traumatic brain injuries (TBI) in Massachusetts for the six-year period 1995-2000. It describes and examines the magnitude, trends, leading causes, populations at highest risk, outcomes, and hospital charges associated with these injuries. The findings, by data sources, are summarized below:

SUMMARY TABLE: TRAUMATIC BRAIN INJURY AMONG MASSACHUSETTS RESIDENTS 1995-2000*

	Deaths	Hospital Discharges	Emergency Department Discharges
Mean Annual Frequency	544	3,752	32,640
Mean Annual Rate	8.6/100,000	59.6/100,000	514.1/100,000
Leading Cause of TBI:	Firearm	Fall	Fall
cases/year (% of TBI)	141 (26%)	1,642 (44%)	13,016 (40%)
Highest Rate Group: Sex	Males	Males	Males
Highest Rate Group: Age	85 years and older	85 years and older	Under 1 year
Highest Rate Group: Race	Black, non-Hispanic	Black, non-Hispanic	Black, non-Hispanic

Data Sources: Registry of Vital Records and Statistics, MA Department of Public Health
Massachusetts Hospital Discharge Database, MA Division of Health Care Finance and Policy
Emergency Department Discharge Data base, MA Division of Health Care Finance and Policy
*2002 data used for emergency department discharges

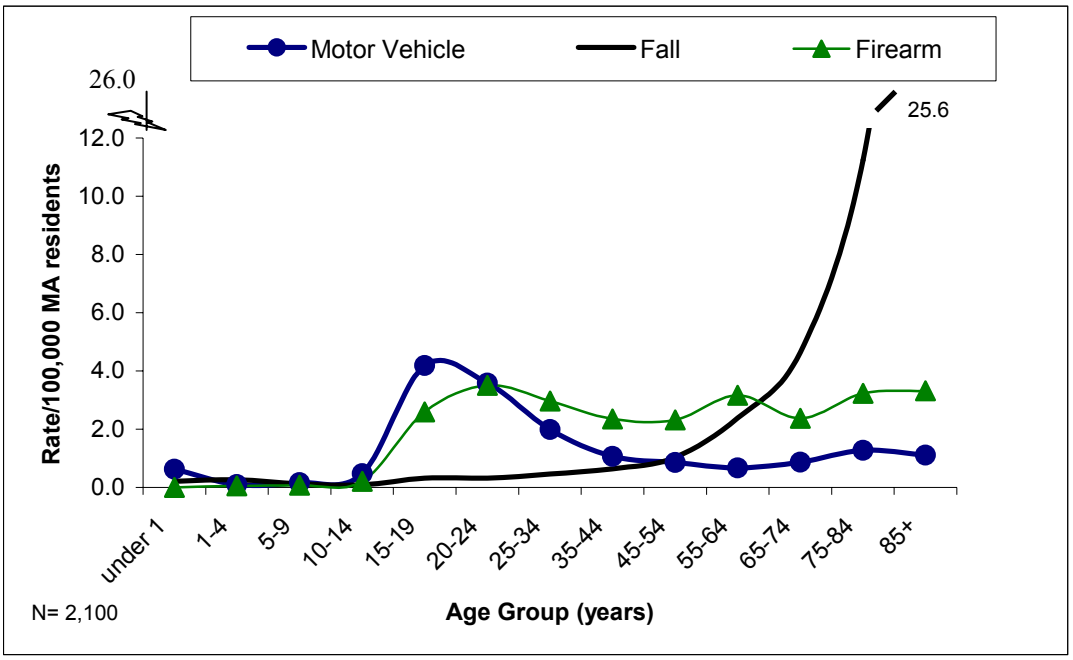
I. TRAUMATIC BRAIN INJURY DEATHS

Magnitude and Trends:

- From 1995 through 2000 there were 3,262 traumatic brain injury (TBI) deaths among Massachusetts residents, an average of 544 deaths per year (8.6/100,000). In 2000, 22% of all injury fatalities in Massachusetts were associated with a TBI.

- From 1995 through 2000, the TBI fatality rates remained relatively stable.

TBI Fatalities: Average Annual Rates by Leading Causes and Age Group, MA Residents, 1995-2000



Data Source: Registry of Vital Records and Statistics, MA Department of Public Health

Leading Causes:

- The three leading causes of TBI deaths from 1995 through 2000 were:

  - **Firearms:** an average of 141 deaths/year. More than a quarter (26%) of all TBI fatalities during this period were firearm-related. Eighty percent of firearm-related TBI deaths were suicides, and 19% were homicides. From 1998 to 2000, firearm-related TBI deaths decreased 23%.

  - **Falls:** an average of 121 deaths/year. Twenty-two percent of all TBI fatalities during this period were fall-related. Fall-related TBI deaths

increased 42% from 1995 (N=95) to 2000 (N=135). Fall-related TBI deaths outnumbered firearm-related TBI fatalities beginning in 1999. Men and women age 75 and over had the highest rates of fatal TBI due to a fall (an average of 65 deaths each year). Twenty-two percent of persons age 75 and over, who suffered a fatal TBI due to a fall in 2000, fell from stairs or steps.

- **Motor Vehicle Occupants:** an average of 88 deaths/year. Sixteen percent of all TBI fatalities during this period involved occupants of motor vehicles. Young persons 15 -19 years of age experienced the highest rate of TBI-related motor vehicle occupant fatalities, accounting for, on average, 20% of these deaths each year. Twenty-one percent of all motor vehicle-related TBI fatalities in 2000 were among pedestrians or bicyclists.

- Sixty percent of TBI deaths were unintentional, 22% were due to suicide, and 9% were due to homicide.

- Pedestrian activities were the leading cause of TBI-associated deaths among children ages 1 through 9 years (N=15), while motor vehicle occupant was the leading cause of TBI deaths for youths 10 to 19 years of age (N=116) from 1995 through 2000.

Risk Groups:

- TBI fatality rates for males were 2.4 times higher than those for females from 1995 through 2000.

- Persons age 85 and older experienced the highest rates of TBI-related death, compared with other age groups.

- Among racial/ethnic groups, Black non-Hispanics experienced the highest rates of fatal TBI (11.1/100,000), 1.3 times higher than the second leading risk group (White non-Hispanics: 8.6/100,000).

  - Sixty-one percent of firearm-related TBI deaths among Black non-Hispanics in 2000 were due to homicide.

  - Eighty-two percent of TBI deaths among White non-Hispanics were due to suicide.

- Infants under age one experienced the highest rates of homicide-related TBI compared to all other age groups from 1995 through 2000 (N=12). Young people 20-24 years of age, however, had the highest overall rates of homicide (with or without TBI) during this time period. The higher rates of TBI among infant homicides (compared with other

age groups) is likely explained by the differences in the mechanisms or causes of these homicides. Among persons 20-24 years of age, the leading mechanism of homicide was a firearm (78%). The leading causes of homicides among infants less than 1 year of age were "unspecified" and "other maltreatment syndromes".

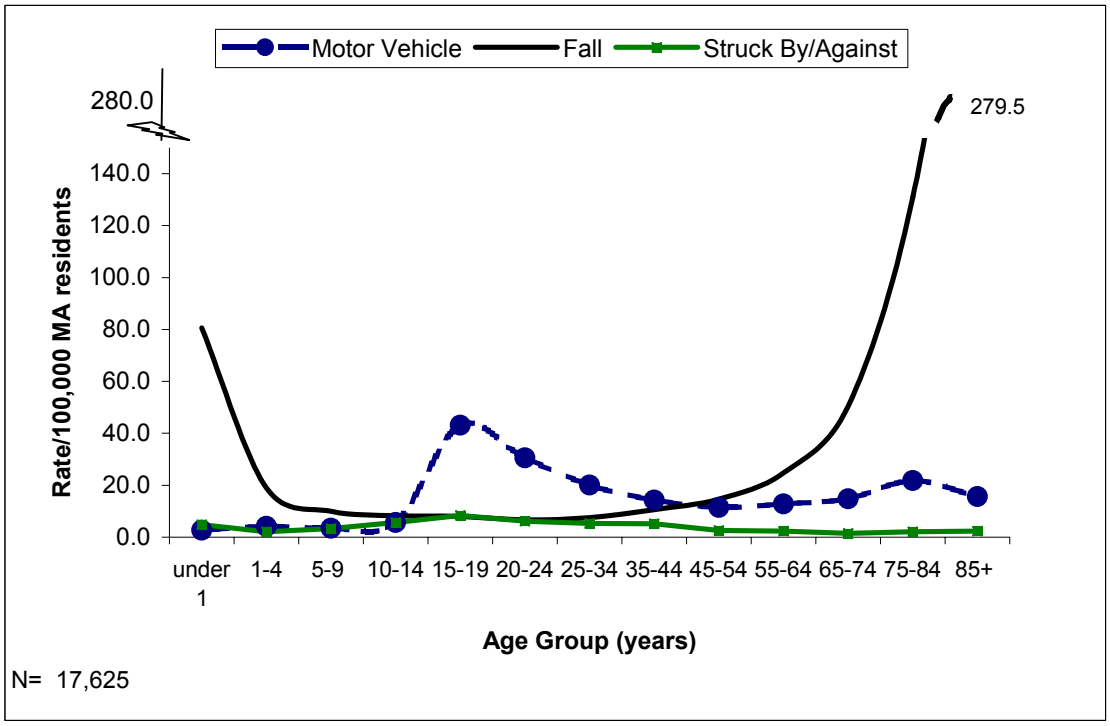
II. HOSPITALIZATIONS FOR NON-FATAL TRAUMATIC BRAIN INJURY

Magnitude and Trends:

- From 1995 through 2000 there were 22,514 traumatic brain injury (TBI)-related hospitalizations among Massachusetts residents, an average of 3,752 hospitalizations each year (59.6/100,000). In addition, there were 1,365 hospital-based outpatient observation stays for TBI (based on 2000 data).

- Since 1995, TBI hospitalization rates have remained relatively stable, following a twenty-eight percent decline from 1990 to 1995.[1] This decline mirrors a nationwide trend and may be due to changes in medical practices which shift the care of persons with less severe TBI to outpatient settings.[2]

TBI Hospital Discharges: Average Annual Rates by Leading Cause and Age Group, MA Residents, 1995-2000



Data Source: Massachusetts Hospital Discharge Database, MA Division of Health Care Finance and Policy

[1] Massachusetts Department of Public Health. *Traumatic Brain Injuries in Massachusetts, Incidence and Prevention*; 1994.
[2] Thurman D. *Trends in hospitalization associated with traumatic brain injury*. JAMA 1999; 282(10); 954-957.

Leading Causes:

- The leading causes of TBI hospitalizations from 1995 through 2000 were:

  - **Falls:** an average of 1,642 hospitalizations/year. Forty-four percent of all TBI hospitalizations during this period were fall-related.

  - **Motor Vehicle Occupants:** an average of 1,030 hospitalizations/year. More than a quarter (27%) of all TBI hospitalizations during this period were occupants of motor vehicles.

  - **Struck by/against an object or person:** an average of 266 hospitalizations/year. Seven percent of all TBI hospitalizations during this period were due to strikes by or against an object or person.

- Eighty-eight percent of TBI hospitalizations were due to unintentional injuries.

Risk Groups:

- TBI hospitalization rates for males were 1.6 times that of females from 1995 through 2000.

- In 2000, 57% of TBI hospitalizations among 15-19 year old males were sustained as a motor vehicle occupant.

- Persons age 85 and older experienced the highest rates of TBI-related hospitalizations, compared with other age groups.

- Infants under the age of one year experienced the highest rates of hospitalization for an assault-related non-fatal TBI compared to all other age groups. In 2000, 11% of children under one year of age with a TBI-related hospitalization were victims of an assault.

- Black non-Hispanics had the highest rates of non-fatal TBI hospitalizations compared to other races. Falls were the leading cause of TBI-related hospitalizations for Whites and Blacks (non-Hispanics), while motor vehicle occupant-related injuries was the leading cause of TBI-related hospitalizations among Asians and Hispanics.

III. EMERGENCY DEPARTMENT DISCHARGES FOR NON-FATAL TRAUMATIC BRAIN INJURY

- Statewide numbers for emergency department visits for non-fatal traumatic brain injuries were not collected for the time period 1995-2000. However, the newly established Massachusetts Emergency Department Database, administered by the MA Division of Health Care Finance and Policy, is now collecting statewide data on these visits. Initial analysis of this database indicates that in 2002, there were 32,640 emergency department discharges for TBI among MA residents (rate of 514/100,000). The leading cause of TBIs treated and released from ED was falls (N= 13,016). Ninety-one percent of TBIs treated in the ED were unintentional.

Conclusion

Although the rates of fatal TBI among MA residents compare favorably with the U.S. as a whole (8.6 per 100,000[1] vs. 19.4 per 100,000[2], respectively), this report underscores the need for continued efforts to reduce the number of these events. As shown by the data, some of the major causes of TBI in Massachusetts are falls (especially among the elderly), motor vehicle occupant injuries (particularly among young people 15-19 years of age), violence against infants (under 1 year of age), and firearm-related suicides.

Prevention of each of these often require a multi-faceted approach involving education, enactment and enforcement of laws, and modifications in the environment where injuries occur. Ongoing surveillance of traumatic brain injuries, including the systematic collection of data on incidence, circumstances, and outcomes is a critical first step in developing a public health approach to preventing these events. It is hoped that the data presented in this report will assist individuals and groups throughout Massachusetts who are leading the effort to prevent or reduce death and disability from these devastating injuries.

[1] 1998 Massachusetts TBI age adjusted rate

[2] (1998 age adjusted rate) Adekoya N, Thurman DJ, White DD, Webb RW. *Surveillance for Traumatic Brain Injury Deaths—United States,1989-1998;* CDC Surveillance Summaries, MMWR December 6, 2002; 51(SS10);1-16.

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INTRODUCTION

Traumatic brain injuries (TBI) are an important public health problem in Massachusetts and across the nation. Each year, an estimated 1.5 million individuals in the U.S. sustain a TBI[1]. This represents eight times the number of people diagnosed with breast cancer and thirty-four times the number of new cases of HIV/AIDS.[2] Compared with other types of injury, brain injuries are among the most likely to cause death or permanent disability. Nationwide, approximately 50,000 of those sustaining a TBI will die of their injury, and another 80,000-90,000 experience the onset of long-term or lifelong disability.[3] The resulting disabilities may include memory and/or speech problems, cognitive deficits, seizures, emotional, movement, and sensory problems. Nationwide in 1995, the estimated direct and indirect costs of these injuries totaled $56.3 billion.[4]

Standard guidelines for identifying TBI have been established by the Centers for Disease Control and Prevention (CDC).[5] A TBI is an occurrence of injury to the head (arising from blunt or penetrating trauma or from acceleration-deceleration forces) that is associated with any of the following symptoms or signs attributable to the injury: decreased level of consciousness, amnesia, other neurologic or neuropsychologic abnormalities, skull fracture, diagnosed intracranial lesions, or death. Exclusions include: 1) lacerations or contusions limited to the eye, ear, face or scalp; 2) birth trauma; 3) primary anoxic, inflammatory, infectious, toxic, or metabolic encephalopathies that are not complications of head trauma; 4) tumors; and 5) brain infarction (ischemic stroke) and intracranial hemorrhage (hemorrhagic stroke) without associated trauma.[6]

This report describes the magnitude of fatal and non-fatal traumatic brain injuries among Massachusetts residents for the six-year period from 1995 to 2000 using death certificate information as well as statewide hospital discharge data. It examines trends, leading causes, populations at risk, outcomes, and hospital charges. A TBI, in this report, may be classified by: 1) the mechanism or cause of the injury (e.g. fall, motor vehicle crash, etc.) or 2) the intent of the injury (e.g. assault, self-inflicted, unintentional). For a case to be included, it must have received one or more International Classification of Disease (ICD) codes fitting the CDC definition of TBI. These codes enable identification of a TBI in the databases used. As such, the data generated for this report is dependent on multiple factors, including the diagnosis and documentation of these injuries and their causes in the medical record or in the death certificate. Certain TBI-related fatalities, for example, may be classified as “multiple traumatic injuries” (e.g. some deaths caused by motor vehicle crashes), and are therefore not included in

[1] CDC, National Center for Injury Prevention and Control (NCIPC). Traumatic Brain Injury Fact Sheet; Accessed December 2003. www.cdc.gov/ncipc/factsheets/tbi.htm www.cdc.gov/ncipc/factsheets/tbi.htm.
[2] ibid
[3] ibid
[4] Thurman DJ, The epidemiology and economics of head trauma. In: Miller L, Hayes R,editors.*Head Trauma: Basic, Preclinical, and Clinical Directions*. New York: Wiley and Sons;2001
[5] National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, *TBI Definition*, November 2001
[6] State and Territorial Injury Prevention Directors Association (STIPDA). *Council of State and Territorial Epidemiologists Injury Indicators for Surveillance*;1999. www.stipda.org/resol/99nphss-tbi.htm.

this report.

This report is an update to a prior report on traumatic brain injuries published in 1994 by the Massachusetts Department of Public Health.[1] That report provided statistics on TBI fatalities and hospitalizations for the year 1990 using the same databases analyzed in this report and Emergency Department discharge estimates extrapolated from Pennsylvania data. This report differs in that it applies a slightly expanded CDC definition of TBI (published and recommended by the CDC, 11/2001) and provides Massachusetts statewide data on ED visits for TBI. Similar to the 1994 report, the hospital discharge data reported includes acute care hospitalizations only; it does not include hospitalizations at long-term care facilities, Veterans Administration, psychiatric or rehabilitation hospitals.

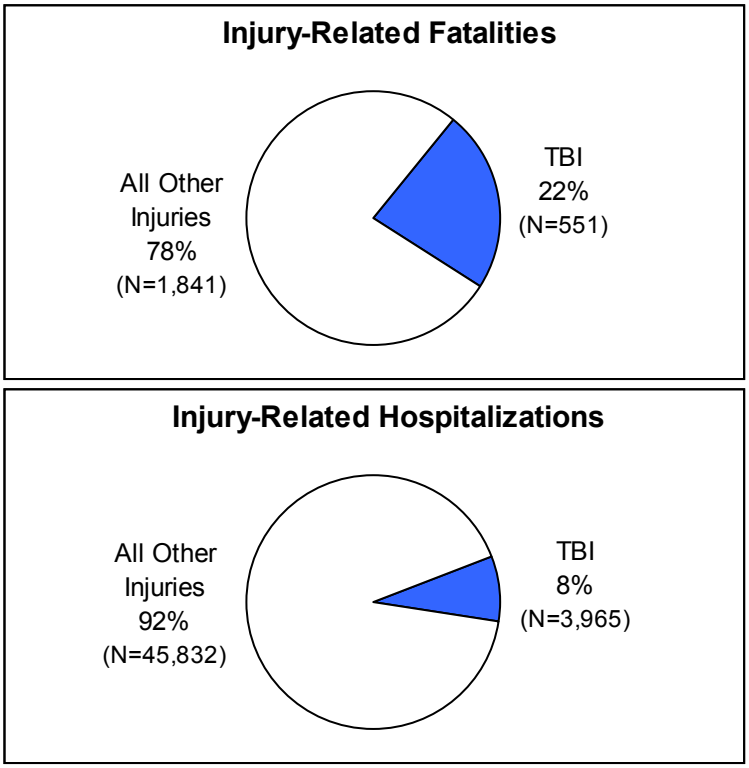
Ongoing surveillance of traumatic brain injuries, including the systematic collection of data on incidence, circumstances, and outcomes is a critical first step in developing a public health approach to preventing these events. It is hoped that the data presented in this report will assist individuals and groups throughout Massachusetts who are leading the effort to prevent or reduce the incidence of death and disability from these often devastating injuries.

[1] Massachusetts Department of Public Health. *Traumatic Brain Injuries in Massachusetts, Incidence and Prevention;* 1994.

TRAUMATIC BRAIN INJURIES IN MASSACHUSETTS

DATA

FIGURE 1: PROPORTION OF TRAUMATIC BRAIN INJURIES TO TOTAL INJURIES MASSACHUSETTS RESIDENTS, 2000



Data Sources: Registry of Vital Records and Statistics, MA Department of Public Health
MA Hospital Discharge Database, MA Division of Health Care Finance and Policy

- The proportion of traumatic brain injury (TBI) among all injury deaths is greater than among all injury-related hospitalizations. Almost a quarter (22%) of all injury fatalities in Massachusetts involved a TBI compared to 8% of hospital injury-related discharges.

TABLE 1: TRAUMATIC BRAIN INJURY FATALITIES
NUMBER AND AVERAGE ANNUAL RATE BY INTENT AND LEADING CAUSES, MA RESIDENTS, 1995-2000

From 1995 through 2000, there were 3,262 TBI fatalities among Massachusetts residents, resulting in an average annual rate of 8.6 deaths per 100,000 residents.

Intent and Cause	1995	1996	1997	1998	1999	2000	Total	Avg. Annual Rate/100,000**
Unintentional	**280**	**292**	**321**	**328**	**375**	**368**	**1,964**	**5.2**
Fall	93	94	112	126	147	133	705	1.9
Motor Vehicle Occupant[1]	76	84	99	94	79	92	524	1.4
Pedestrian[2]	31	26	28	17	30	24	156	0.4
Pedal Cyclist[2]	4	6	6	0	5	7	28	0.1
Struck By/Against	6	3	5	4	6	3	27	0.1
Other Causes	70	79	71	87	108	109	524	1.4
Suicide	**133**	**117**	**122**	**137**	**106**	**92**	**707**	**1.9**
Firearm	122	112	116	132	102	90	674	1.8
Fall	2	3	4	5	3	1	18	<0.1
Other Causes	9	2	2	0	1	1	15	<0.1
Homicide	**61**	**59**	**45**	**39**	**34**	**46**	**284**	**0.8**
Firearm	34	33	18	25	19	28	157	0.4
Struck By/Against	5	5	1	5	4	3	23	0.1
Other Causes	22	21	26	9	11	15	104	0.3
Undetermined	**10**	**11**	**11**	**10**	**9**	**8**	**59**	**0.2**
Firearm	1	1	1	1	3	1	8	<0.1
Poisoning	1	1	0	1	0	0	3	--
Other Causes	8	9	10	8	6	7	48	0.1
Other[3]	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.0**
No external cause of injury listed	43	46	37	47	38	37	248	0.7
TOTAL	**527**	**525**	**536**	**561**	**562**	**551**	**3,262**	**8.6**

** rates based on frequencies less than 20 may be unstable and should be interpreted with caution. Rates that are based on cases less than 5 are not reported.

[1] Also includes motor vehicle unspecified injuries

[2] These include motor vehicle and non-motor vehicle-related crashes

[3] Includes legal intervention and operations of war

Data Source: Registry of Vital Records and Statistics, MA Department of Public Health

TABLE 2: TRAUMATIC BRAIN INJURY HOSPITALIZATIONS
NUMBER AND AVERAGE ANNUAL RATE BY INTENT AND LEADING CAUSES, MA RESIDENTS, 1995-2000

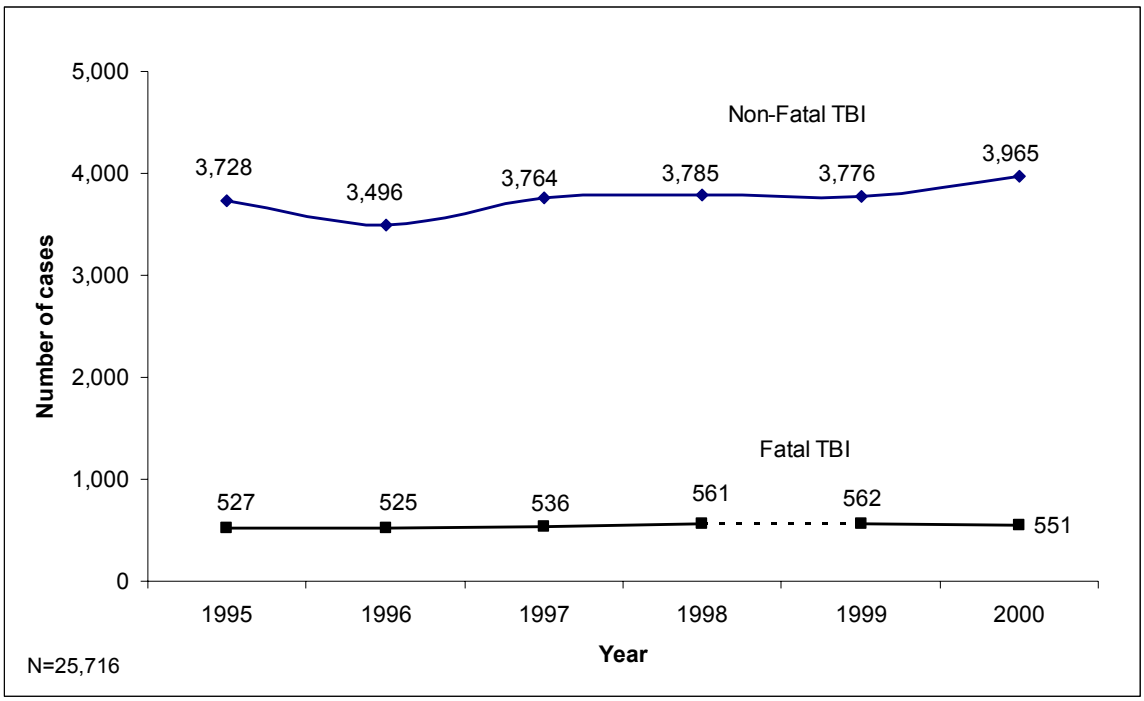
From 1995 through 2000, there were 22,514 non-fatal TBI hospitalizations among Massachusetts residents, resulting in an average annual rate of 59.6 deaths per 100,000 residents.

Intent and Cause	1995	1996	1997	1998	1999	2000	Total	Avg. Annual Rate/100,000**
Unintentional	**3,282**	**3,034**	**3,372**	**3,359**	**3,160**	**3,590**	**19,797**	**52.4**
Fall	1,489	1,446	1,620	1,658	1,652	1,943	9,808	26.0
Motor Vehicle Occupant[1]	1,101	929	1,106	1,070	951	1,011	6,168	16.3
Pedestrian[2]	262	246	239	208	201	224	1,380	3.7
Pedal Cyclist[2]	153	133	141	147	118	130	822	2.2
Struck By/Against	115	125	116	110	93	121	680	1.8
Transport, other	48	60	60	63	59	64	354	0.9
Other Causes	114	95	90	103	86	97	585	1.5
Self-Inflicted	**16**	**12**	**7**	**16**	**17**	**23**	**91**	**0.2**
Fall	6	4	2	6	3	5	26	0.1
Firearm	2	2	0	2	2	4	12	<0.1
Other Causes	8	6	5	8	12	14	53	0.1
Assault	**259**	**219**	**239**	**245**	**225**	**232**	**1,419**	**3.8**
Struck By/Against	160	154	158	153	128	159	912	2.4
Unspecified	52	36	47	43	47	41	266	0.7
Other Causes	47	29	34	49	50	37	246	0.7
Undetermined	**14**	**20**	**4**	**16**	**11**	**9**	**74**	**0.2**
Fall	4	4	1	2	1	2	14	<0.1
Firearm	1	3	0	2	0	1	7	<0.1
Other Causes	9	13	3	12	10	5	52	0.1
Other[3]	**3**	**2**	**1**	**0**	**0**	**0**	**6**	**<0.1**
Adverse Effects[4]	26	36	21	25	30	37	175	0.5
No external cause of injury listed	128	173	120	124	333	74	952	2.5
TOTAL	**3,728**	**3,496**	**3,764**	**3,785**	**3,776**	**3,965**	**22,514**	**59.6**

** rates based on frequencies less than 20 may be unstable and should be interpreted with caution. Rates that are based on cases less than 5 are not reported; [1] Also includes motor vehicle unspecified injuries; [2] These include motor vehicle and non-motor vehicle-related crashes;
[3] Includes legal intervention and operations of war; [4] Includes misadventures to patients due to surgical and medical care. Also includes drugs, medicinal, and biological substances causing adverse effects in therapeutic use.
Data Source: Massachusetts Hospital Discharge Database, MA Division of Health Care Finance and Policy

TRAUMATIC BRAIN INJURY DEATHS AND HOSPITALIZATIONS

FIGURE 2: TRAUMATIC BRAIN INJURY DEATHS AND HOSPITAL DISCHARGES, MA RESIDENTS, 1995-2000



Data Sources: Registry of Vital Records and Statistics, MA Department of Public Health
MA Hospital Discharge Database, MA Division of Health Care Finance and Policy
Note: Dotted line represents change in coding protocol beginning in 1999 (from ICD-9 to ICD-10)

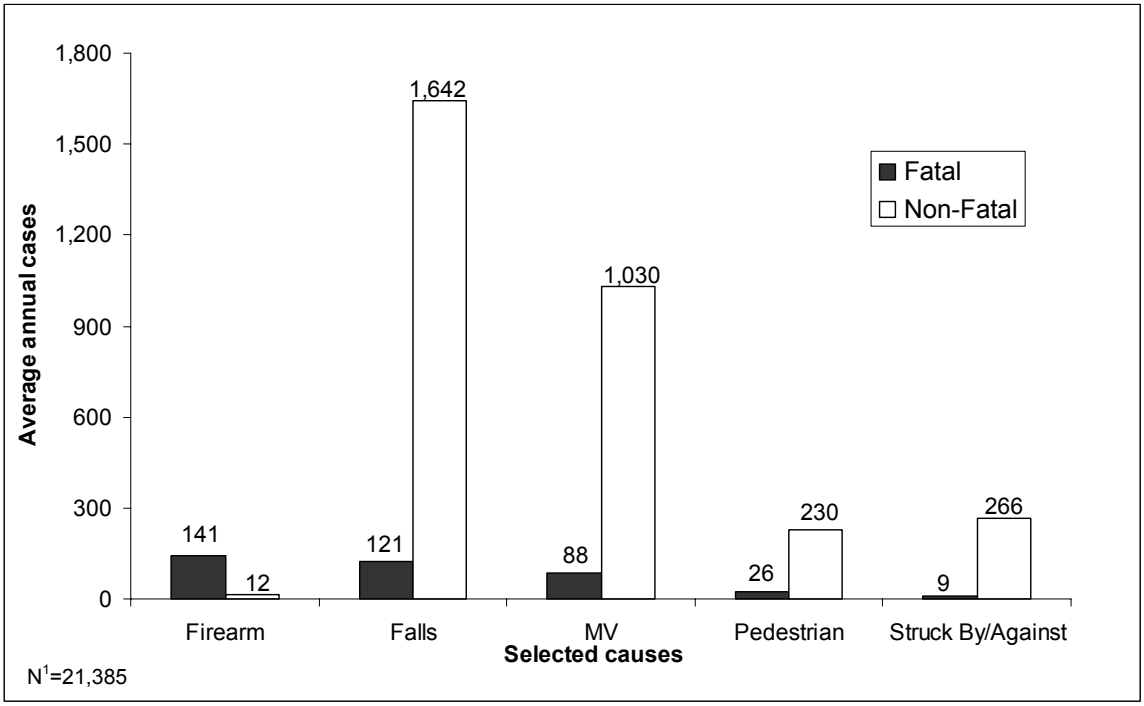
- In 2000, there were 551 TBI fatalities and 3,965 non-fatal TBI hospitalizations among Massachusetts residents. There were an additional 1,365 hospital-based outpatient observation stays for TBI (data not shown).[1]

- The numbers and rates of TBI fatalities have remained relatively stable since 1990 (6% decline in cases from 1990 to 2000). TBI fatality rates between 1995 and 2000 have remained stable, ranging from 8.6/100,000 in 1995 to 8.7/100,000 in 2000.

- Since 1995, TBI hospitalization rates have remained relatively stable (60.7/100,000 in 1995 and 62.4/100,000 in 2000), following a 28% decline from 1990 to 1995.[2] This decline mirrors a nationwide trend and may be due to changes in medical practices which shift the care of persons with less severe TBI to outpatient settings.[3]

[1] A general definition of Outpatient Observation services is defined for reporting purposes in the Case Mix Regulation 114.1 CMR 17.02 as: *Observation services are those furnished on a hospital's premises which are reasonable and necessary to further evaluate a patient's condition and provide treatment to determine the need for possible admission to the hospital. These services include the use of a bed and periodic monitoring by a hospital's physician, nursing and other staff.*
[2] Massachusetts Department of Public Health. *Traumatic Brain Injuries in Massachusetts, Incidence and Prevention*; 1994.
[3] Thurman D. *Trends in hospitalization associated with traumatic brain injury*. JAMA 1999; 282(10); 954-957.

FIGURE 3: AVERAGE ANNUAL NUMBERS OF TRAUMATIC BRAIN INJURY DEATHS AND HOSPITAL DISCHARGES BY SELECTED CAUSES, MA RESIDENTS, 1995-2000



Data Sources: Registry of Vital Records and Statistics, MA Department of Public Health
MA Hospital Discharge Database, MA Division of Health Care Finance and Policy

[1] Total cases of selected injuries over the period.

From 1995 through 2000:

- Firearms were the leading cause of TBI fatalities. Seventy percent of all fatal firearm injuries in 2000 were associated with a TBI. Firearms were the only leading cause of TBI in which fatalities outnumbered non-fatal cases by 12 to 1.

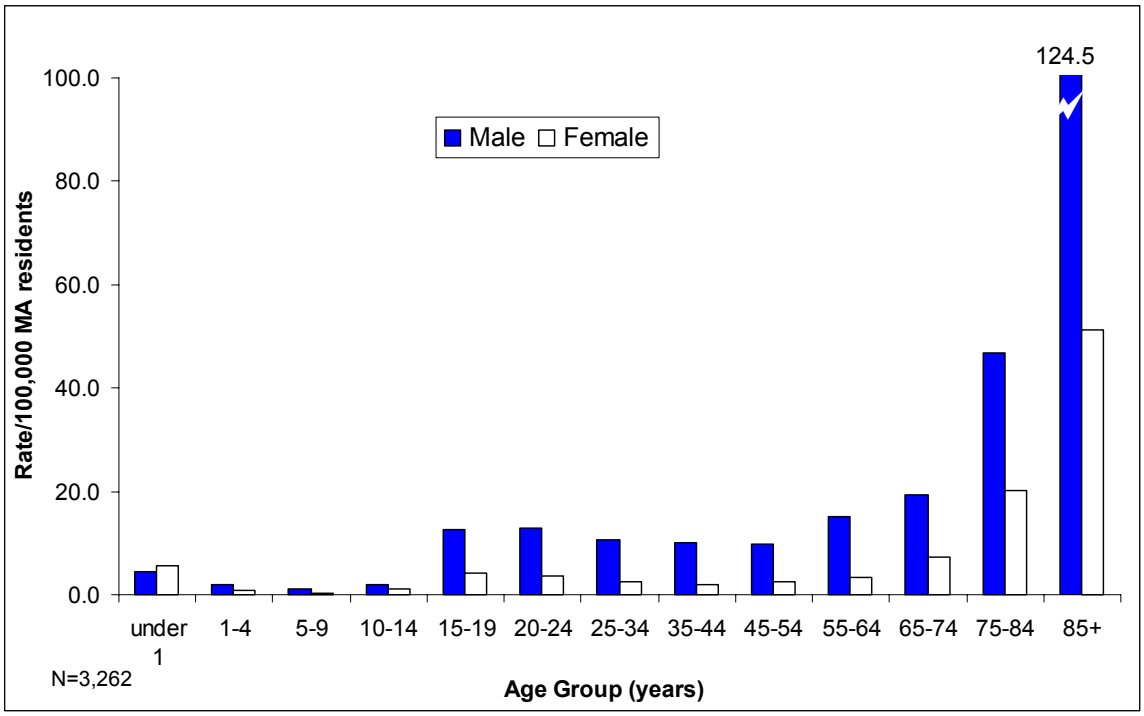
  - Eighty percent of these firearm fatalities were suicides. Self-inflicted firearm injuries have a 90% case fatality rate.

- Falls were the second leading cause of TBI mortality. Sixty-one percent of all fatal falls in 2000 were associated with a TBI.

- Falls were the leading cause of TBI–related hospital discharges followed by motor vehicle occupant-related causes.

- The ratio of fatal to non-fatal TBI by other leading causes were: Falls: 1 to 14; MV Occupant: 1 to 12; Pedestrian: 1 to 9; and Struck by/against another person or object: 1 to 31.

FIGURE 4: TBI FATALITIES: AVERAGE ANNUAL RATES BY AGE GROUP AND SEX, MA RESIDENTS, 1995-2000

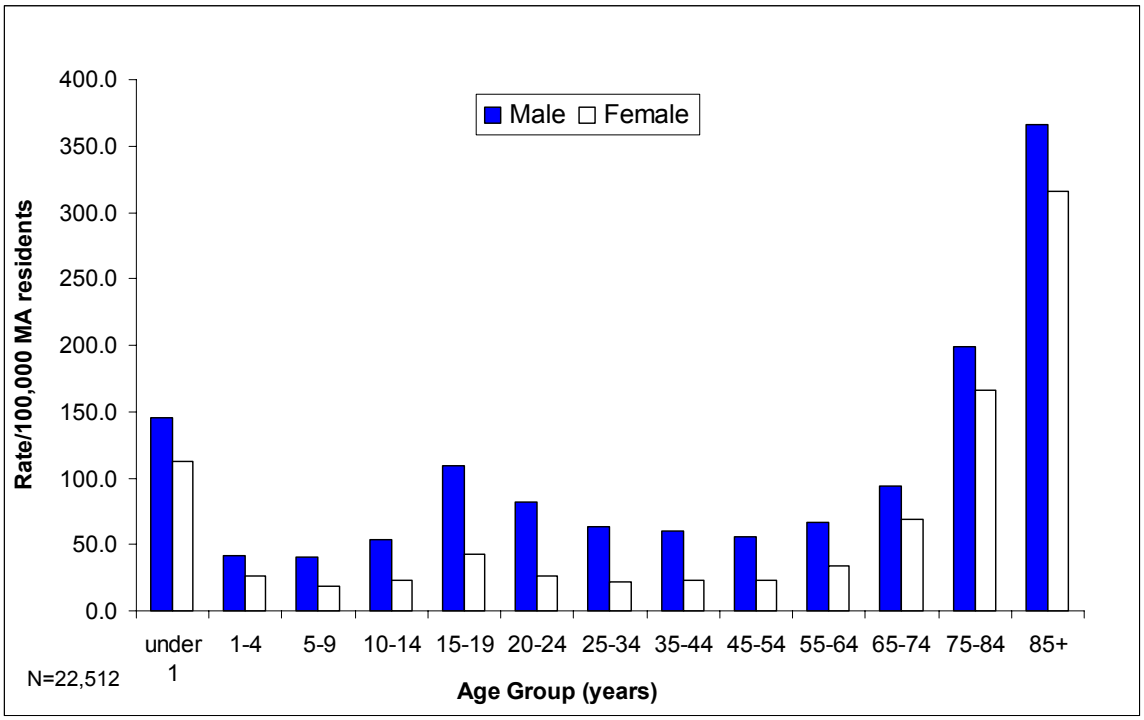


Data Source: Registry of Vital Records and Statistics, MA Department of Public Health

From 1995 through 2000:

- Male TBI fatality rates outnumbered rates for females for all age groups except for infants under the age of one year.
- For both males and females, the highest rates of fatal TBI were at the tail end of the age spectrum. Males 85 years and older had rates almost 2.4 times that of females in this age group. Falls were the leading cause of TBI-related fatalities for males and females in this age group.
- Firearms were the leading cause of TBI-related fatalities for males (33%) while falls were the leading cause of TBI-related fatalities for females (29%).

FIGURE 5: TBI HOSPITAL DISCHARGES: AVERAGE ANNUAL RATES BY AGE GROUP AND SEX, MA RESIDENTS, 1995-2000



Data Source: Massachusetts Hospital Discharge Database, MA Division of Health Care Finance and Policy

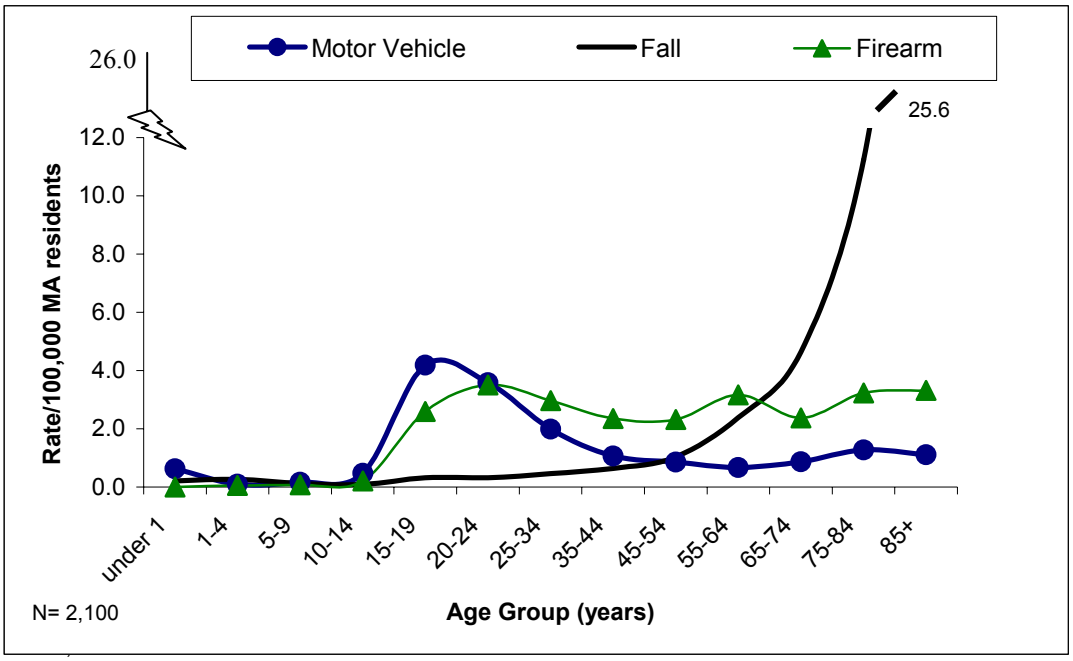
From 1995 through 2000:

- Males and females 85 years and older had the highest rates of non-fatal TBI hospitalizations (366/100,000 and 316/100,000 respectively). Eighty-five percent of these TBI cases were due to falls.

- Infants under the age of one year also had a high rate of non-fatal TBI, compared with age groups 1-74 years of age. The majority (62%) of TBI injuries to infants under one year of age were due to falls. Twenty-three percent of these falls were from stairs/steps, 11% were from beds, and 11% were from chairs.

- Falls were the leading cause of non-fatal TBI-related hospitalizations for both males (37%) and females (54%).

FIGURE 6: TBI FATALITIES: AVERAGE ANNUAL RATES BY LEADING CAUSES AND AGE GROUP, MA RESIDENTS, 1995-2000

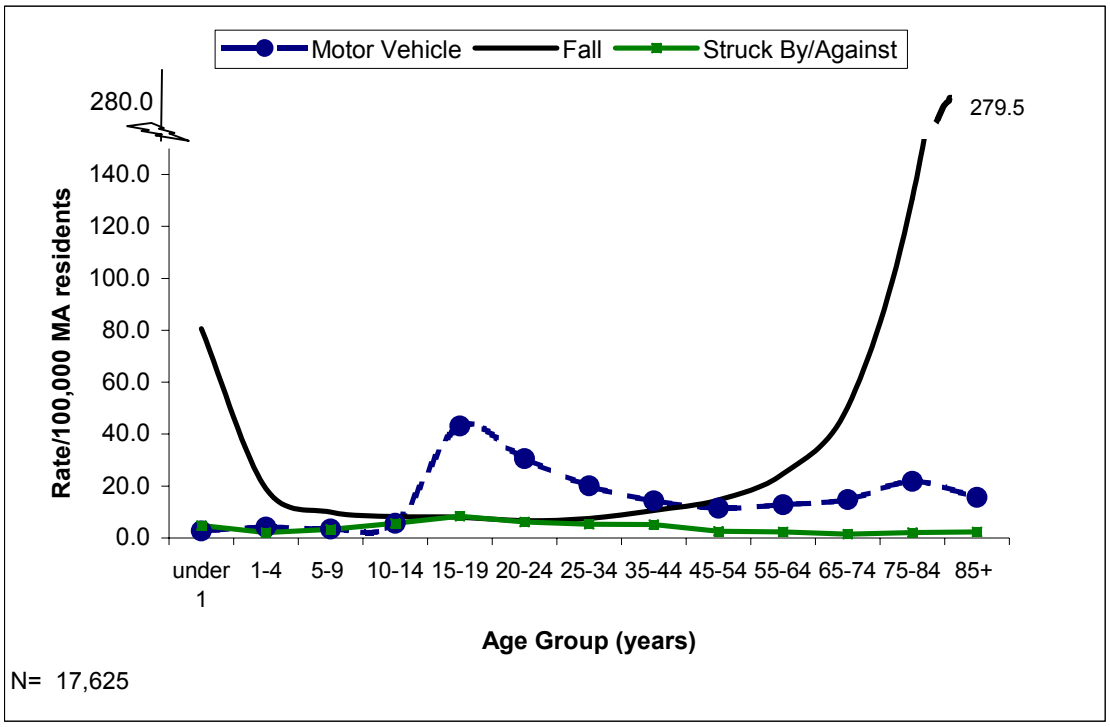


Data Source: Registry of Vital Records and Statistics, MA Department of Public Health
* Please note change in scale on vertical axis

From 1995 through 2000:

- Firearms were the leading cause of fatal TBIs among individuals 25 to 64 years of age.
- More than a third (37%) of TBI fatalities to persons 65 years of age and older were due to falls.
- Individuals, 15 to 24 years of age, had the highest rate of sustaining a motor vehicle occupant-related TBI fatality.

FIGURE 7: TBI HOSPITAL DISCHARGES: AVERAGE ANNUAL RATES BY LEADING CAUSE AND AGE GROUP, MA RESIDENTS, 1995-2000



Data Source: Massachusetts Hospital Discharge Database, MA Division of Health Care Finance and Policy
* Please note change in scale on vertical axis

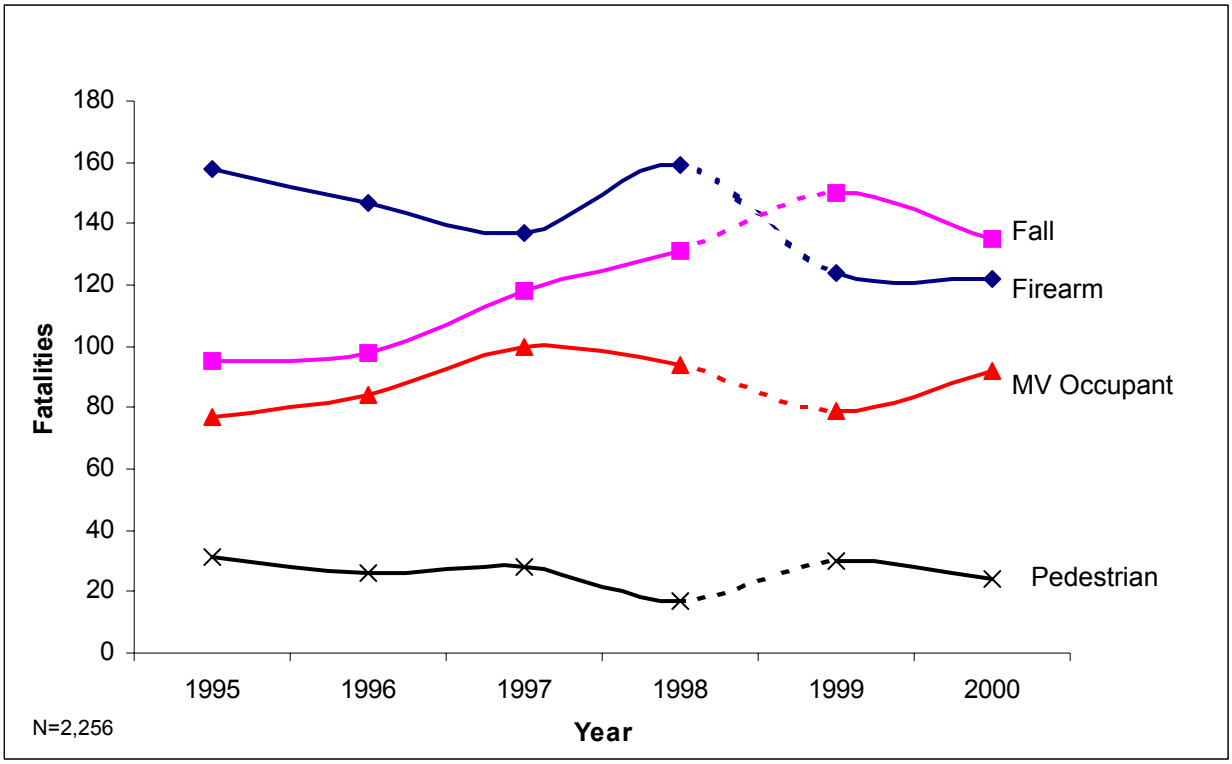
From 1995 through 2000:

- Persons 75 years of age and older had the highest rates of non-fatal fall-related TBI hospitalizations, followed by infants under the age of one year (80.6/100,000).

- Youths, 15-19 years of age, had the highest rate of motor vehicle occupant-related TBI hospitalizations (43.1/100,000).

- Youths, 15-19 years of age, also had the highest rate of TBI hospitalizations caused by strikes by/against an object or person (8.4/100,000). These include injuries caused by an unarmed fight or brawl, a falling object, or being struck during sports, among others.

FIGURE 8: TBI FATALITIES: LEADING CAUSES BY YEAR, MA RESIDENTS, 1995-2000

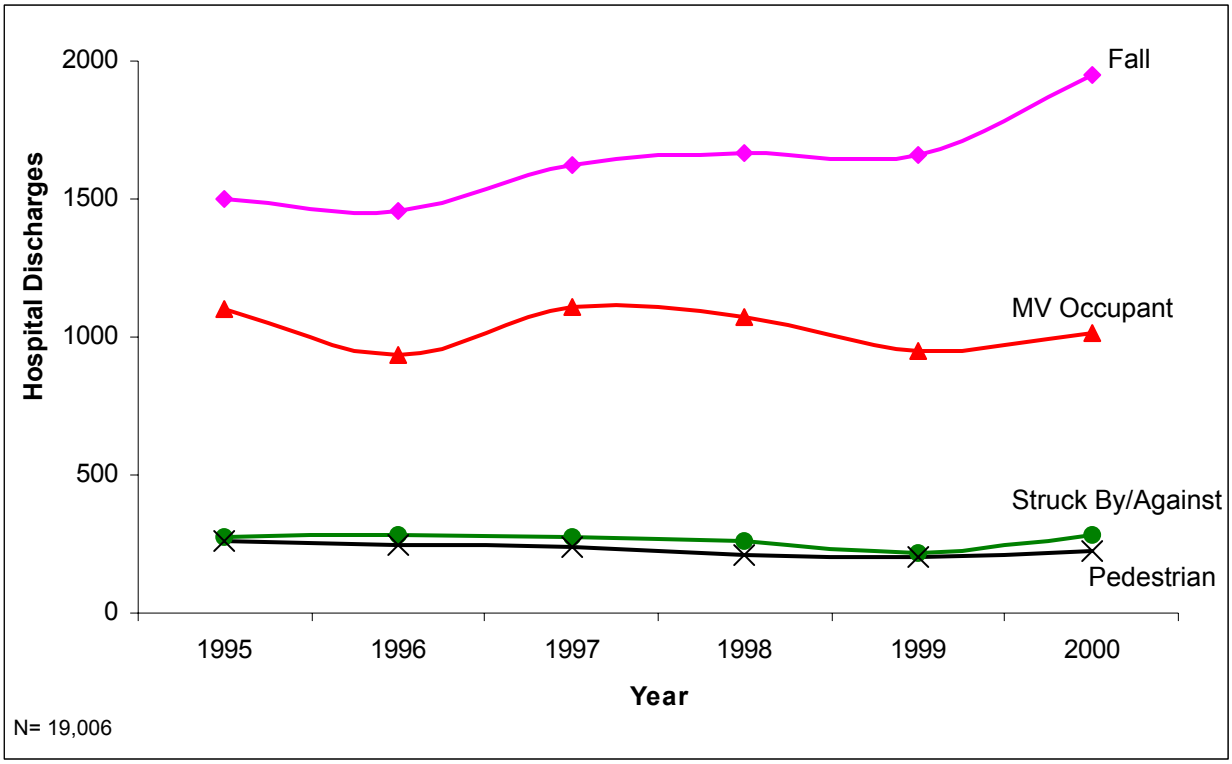


Note: Dotted line represents change in coding protocol beginning in 1999 (from ICD-9 to ICD-10)
Data Source: Registry of Vital Records and Statistics, MA Department of Public Health

From 1995 to 2000:

- Firearm-related TBI fatalities, which were the leading cause of TBI associated deaths from 1995 to 1998, decreased 23%.
- Fall-related TBI fatalities, which became the leading cause of TBI associated deaths beginning in 1999, increased 42%.
    - Men and women 75 years of age and older had the highest rates of fatal TBI due to a fall. Of the eighty-six people 75 years of age and older who suffered a fatal TBI due to a fall in 2000, 22% fell from stairs or steps. Fifty-nine percent of these people were injured at home and another 16% were injured at a residential facility (e.g. nursing home).
- Motor vehicle occupant and pedestrian-related TBI fatalities remained relatively stable.

FIGURE 9: TBI HOSPITAL DISCHARGES: LEADING CAUSES BY YEAR, MA Residents, 1995-2000

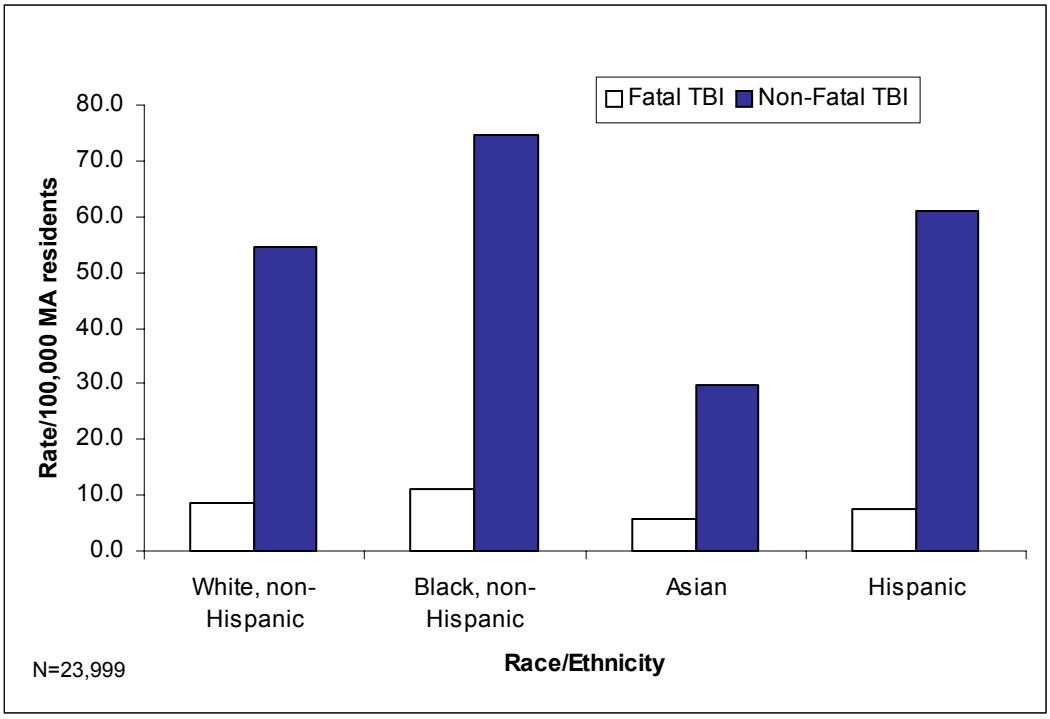


Data Source: Massachusetts Hospital Discharge Database, MA Division of Health Care Finance and Policy

From 1995 to 2000:

- Fall-related TBI hospitalizations increased 30% from 1,500 cases in 1995 to 1,950 cases in 2000.
- Motor vehicle occupant-related TBI cases remained steady throughout this time period at an average of 1,030 cases a year.
- There were an average of 266 TBI hospitalizations caused by strikes by or against a person or object and 230 TBI hospitalizations among pedestrians each year. Examples of a "struck by/against" injury include: struck by falling object, hit by a ball/person during sports, and unarmed fight or brawl.

FIGURE 10: AVERAGE ANNUAL RATES OF TRAUMATIC BRAIN INJURY DEATHS AND HOSPITAL DISCHARGES BY RACE/ETHNICITY, MA RESIDENTS, 1995-2000



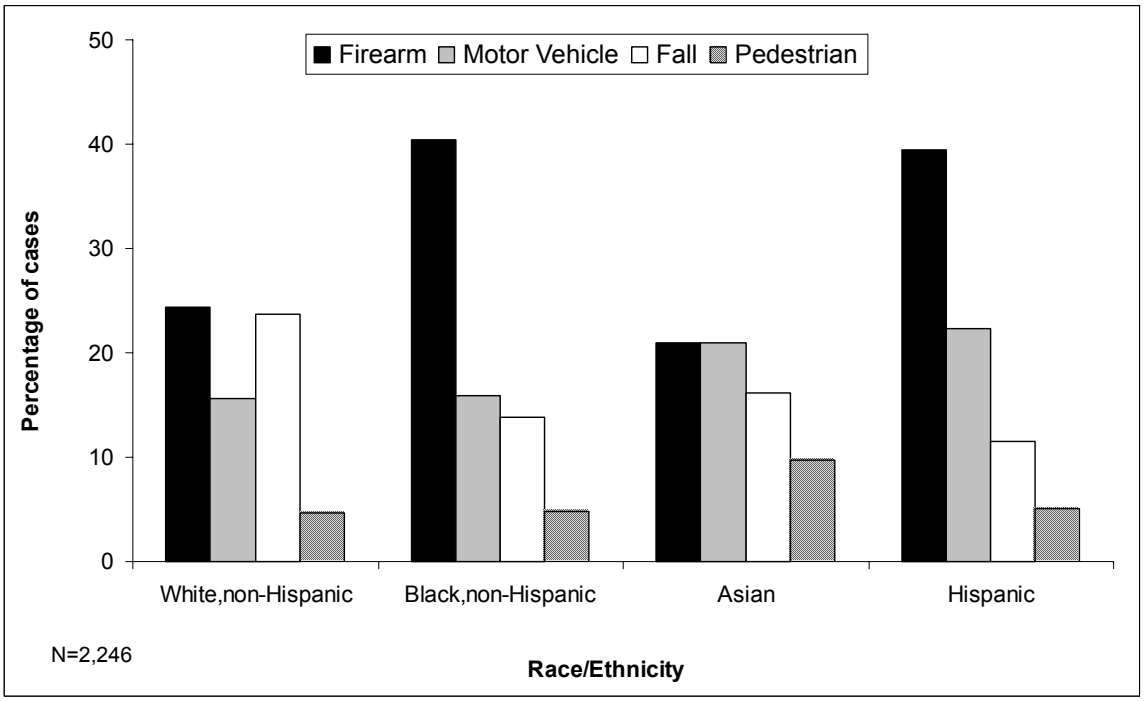
Data Sources: Registry of Vital Records and Statistics, MA Department of Public Health, Massachusetts Hospital Discharge Database, MA Division of Health Care Finance and Policy

From 1995 through 2000:

- Black non-Hispanics had the highest rate of fatal TBI (11.2/100,000), 1.3 times higher than the second leading group (White non-Hispanic: 8.6/100,000).

- For non-fatal TBI hospitalizations, Black non-Hispanics also experienced the highest rate (74.5/100,000) followed by Hispanics (60.8/100,000).

FIGURE 11: TBI FATALITIES: PROPORTION OF LEADING CAUSES BY RACE/ETHNICITY, MA RESIDENTS, 1995-2000



Data Source: Registry of Vital Records and Statistics, MA Department of Public Health

From 1995 through 2000:

- The distribution of leading causes of TBI fatalities varied by race/ethnicity.
- Firearms were the leading cause of TBI fatality for all races and ethnicities (tied with motor vehicle-occupant for Asians).
  - Sixty-one percent of firearm-related TBI deaths among Black non-Hispanics and 15% firearm-related deaths among White non-Hispanics in 2000 were homicides.
  - Eighty-two percent of firearm-related TBI deaths among White non-Hispanics were suicides.

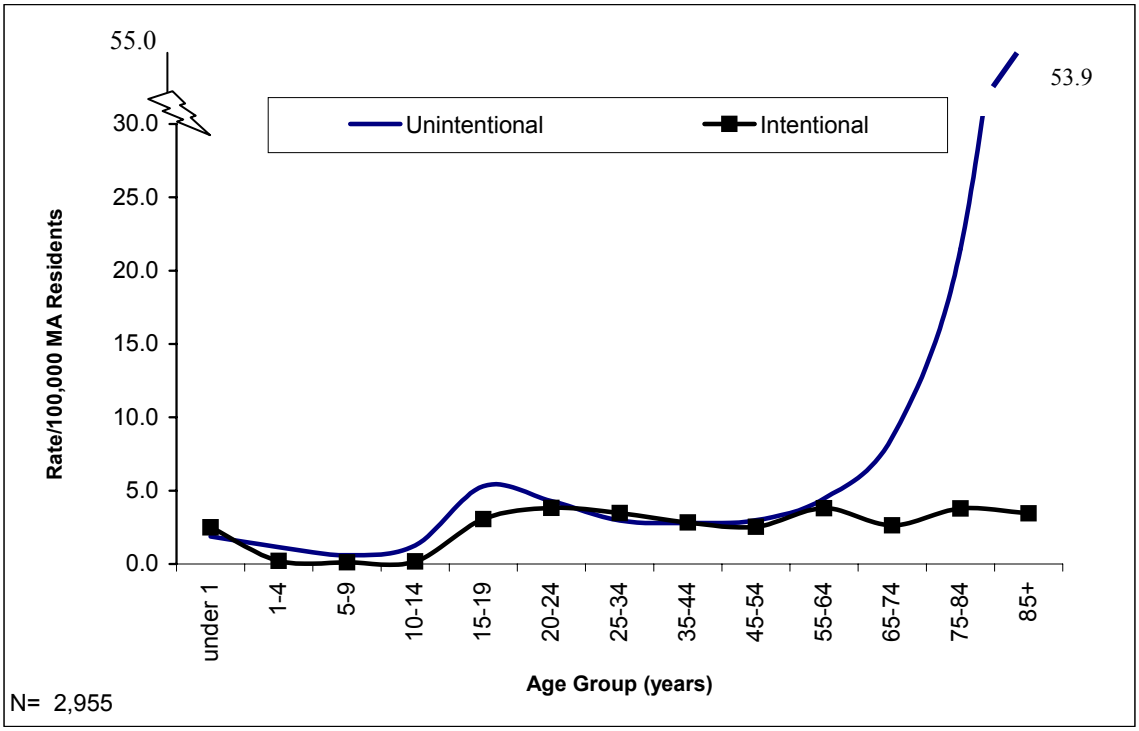
TABLE 4: FATAL AND NON-FATAL TRAUMATIC BRAIN INJURIES, LEADING CAUSE BY RACE/ETHNICITY, MA RESIDENTS, 1995-2000

TBI Fatalities			Non-Fatal TBI Hospitalizations		
Total Fatalities*	**3,262**		**Total Non-Fatal Hospitalizations***		**22,514**
White, non-Hispanic	**n**	**%**	**White, non-Hispanic**	**n**	**%**
Firearm	692	24.4	Fall	8,430	47.1
Fall	671	23.7	Motor vehicle occupant	4,834	27.0
Unspecified	448	15.8	Struck by/Against	1,094	6.1
Motor vehicle occupant	441	15.6	Pedestrian	950	5.3
Pedestrian	132	4.7	Pedal Cyclist	585	3.3
All other injuries	447	15.8	All other injuries	2,012	11.2
Total	2,831	100.0	Total	17,905	100.0
Average annual rate/100,000	*8.6*		*Average annual rate/100,000*	*54.6*	
Black, non-Hispanic	**n**	**%**	**Black, non-Hispanic**	**n**	**%**
Firearm	76	40.4	Fall	356	28.4
Motor vehicle occupant	30	16.0	Motor vehicle occupant	313	25.0
Fall	26	13.8	Struck by/Against	177	14.1
Unspecified	17	9.0	Pedestrian	123	9.8
All other injuries	39	20.7	All other injuries	283	22.6
Total	188	100.0	Total	1252	100.0
Average annual rate/100,000	*11.3*		*Average annual rate/100,000*	*75.1*	
Asian	**n**	**%**	**Asian**	**n**	**%**
Firearm	13	21.0	Motor vehicle occupant	116	36.6
Motor vehicle occupant	13	21.0	Fall	99	31.2
Fall	10	16.1	Pedestrian	37	11.7
Unspecified	12	19.4	Struck by/Against	24	7.6
All other injuries	14	22.6	All other injuries	41	12.9
Total	62	100.0	Total	317	100.0
Average annual rate/100,000	*5.8*		*Average annual rate/100,000*	*29.9*	
Hispanic	**n**	**%**	**Hispanic**	**n**	**%**
Firearm	62	39.5	Motor vehicle occupant	410	31.9
Motor vehicle occupant	35	22.3	Fall	359	27.9
Unspecified	17	10.8	Struck by/Against	160	12.4
Fall	18	11.5	Pedestrian	134	10.4
All other injuries	25	15.9	All other injuries	224	17.4
Total	157	100.0	Total	1,287	100.0
Average annual rate/100,000	*7.6*		*Average annual rate/100,000*	*62.7*	

Data Sources: Registry of Vital Records and Statistics, MA Department of Public Health
Massachusetts Hospital Discharge Database, MA Division of Health Care Finance and Policy

* Totals include persons of other, unknown, and unspecified race.

FIGURE 12: TBI FATALITIES: AVERAGE ANNUAL RATES BY INTENT AND AGE GROUP, MA RESIDENTS, 1995-2000

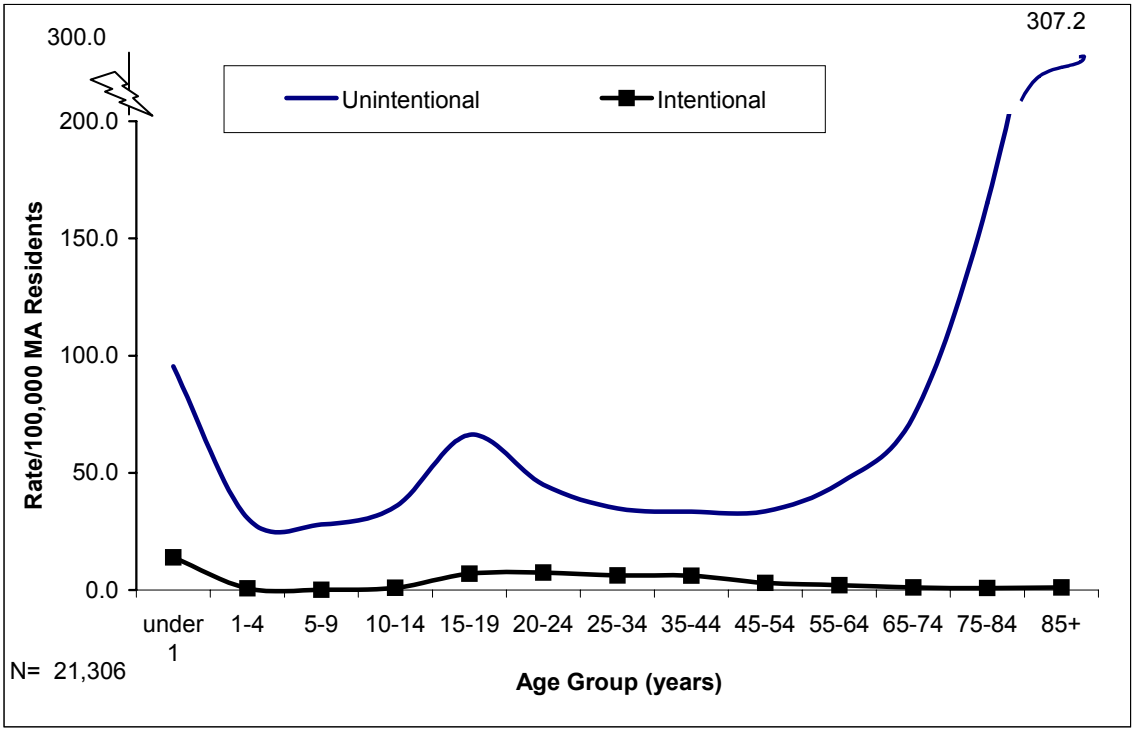


Data Source: Registry of Vital Records and Statistics, MA Department of Public Health
* Please note change in scale on vertical axis.

From 1995 through 2000:

- Intentional (homicide and suicide) and unintentional TBI fatality rates paralleled each other until the tail end of the life span (65+ years), wherein unintentional rates increased while rates from intentional injuries remained stable. Persons 85 years and older were 15 times more likely to die from an unintentional TBI injury compared to an intentional TBI injury.

FIGURE 13: TBI HOSPITAL DISCHARGES: AVERAGE ANNUAL RATES BY INTENT AND AGE GROUP, MA RESIDENTS, 1995-2000



Data Source: Massachusetts Hospital Discharge Database, MA Division of Health Care Finance and Policy
* Please note change in scale on vertical axis.

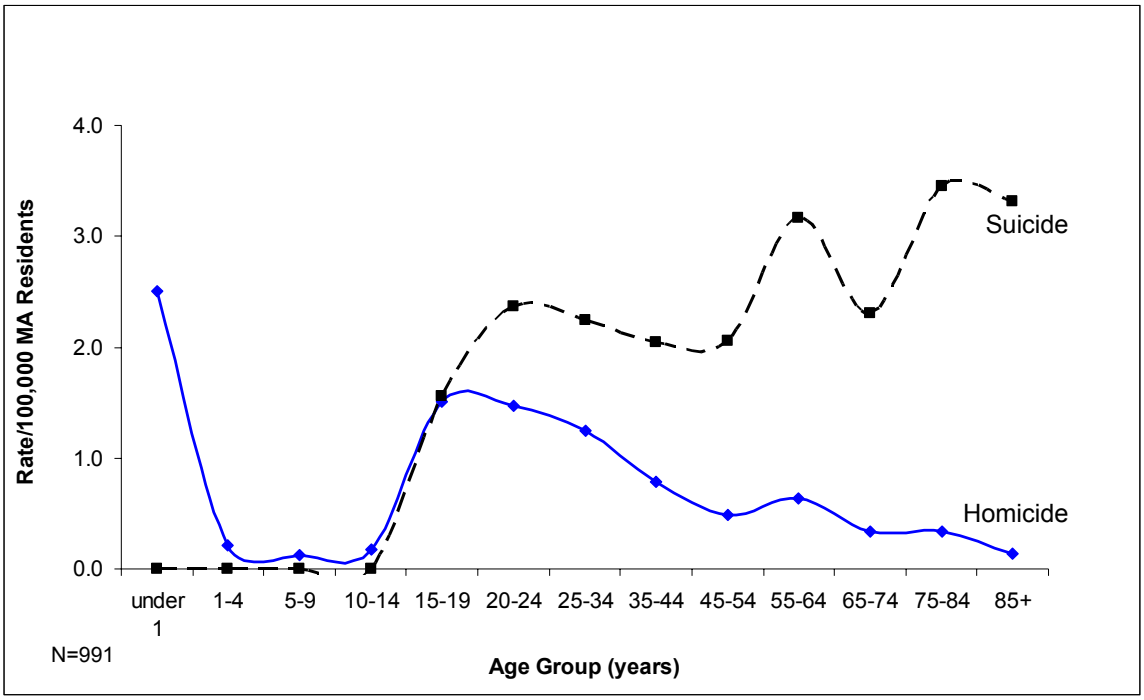
From 1995 through 2000:

- For non-fatal TBI hospitalizations, unintentional injuries outnumbered intentional (assault-related and self-inflicted) injuries for all age groups. The highest rate of intentional TBI hospitalizations was among infants under the age of one year (14.0/100,000).

- Persons 75 years and older had the highest rate of unintentional TBI-related hospitalizations followed by infants under the age of one year.

- Persons 65 to 74 years of age and 15 to 19 years of age also experienced high rates of unintentional TBI hospitalization compared with other age groups.

FIGURE 14: TBI FATALITIES: AVERAGE ANNUAL RATES OF INTENTIONAL INJURIES BY AGE GROUP, MA RESIDENTS, 1995-2000



Data Source: Registry of Vital Records and Statistics, MA Department of Public Health

From 1995 through 2000:

- Infants under the age of one year had the highest rate of TBI due to homicide (N=12). Homicide-related TBI deaths were also high among persons 15-34 years of age compared to other age groups.

  - Young people 20-24 years of age, however, had the highest overall rates of homicide (with or without TBI) during this time period. The higher rates of TBI among infant homicides compared with other age groups is likely explained by the differences in the mechanisms or causes of these homicides. Among persons 20-24 years of age, the leading mechanism of homicide was a firearm (78%). The leading causes of homicides among infants less than 1 year of age were "unspecified" or "other maltreatment syndromes".

- Persons 75 years and older had the highest rates of suicide-related TBI.

In 2000, 98% of all TBIs due to suicide were firearm-related.

FIGURE 15: TBI HOSPITAL DISCHARGES: AVERAGE ANNUAL RATES OF INTENTIONAL INJURIES BY AGE GROUP, MA RESIDENTS, 1995-2000

Data Source: Massachusetts Hospital Discharge Database, MA Division of Health Care Finance Policy

From 1995 through 2000:

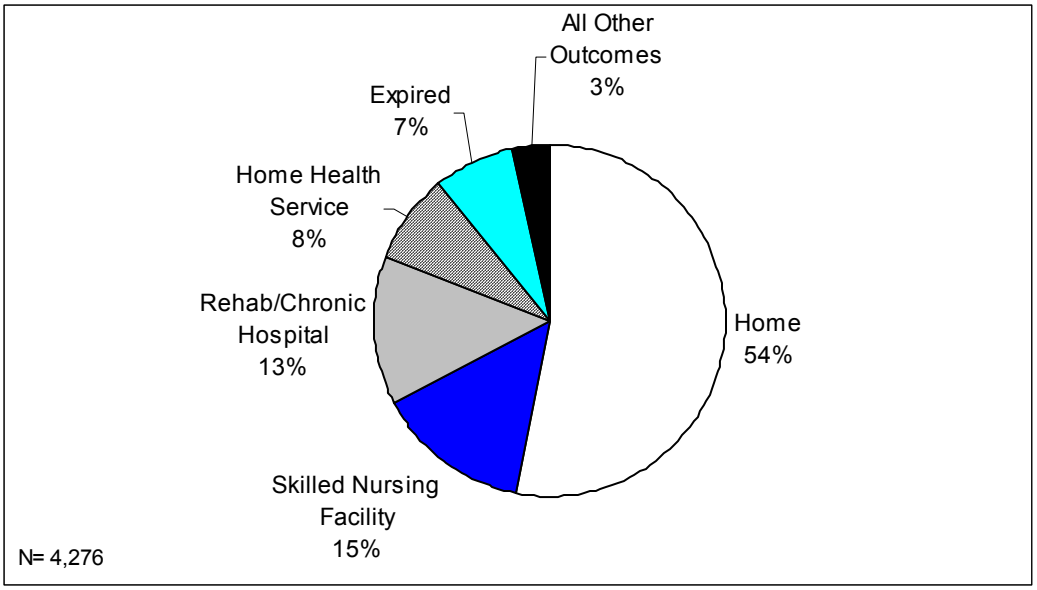
- Rates for non-fatal self-inflicted hospitalizations for TBI were low since the vast majority of these were firearm-related, almost all of which were lethal.
- Infants under the age of one year sustained the highest rate of TBI-related hospitalizations due to assaults (N=67). The rate among this age group was 2.2 times greater than among persons 15-44 years of age.

TABLE 5: FATAL AND NON-FATAL TRAUMATIC BRAIN INJURIES TO CHILDREN, LEADING CAUSES BY AGE GROUP, MA RESIDENTS (0-19 YEARS), 1995-2000

TBI Fatalities			Non-Fatal TBI Hospitalizations		
Total Fatalities	**319**		**Total Non-Fatal Hospitalizations**	**4,844**	
Under 1 year	**n**	**%**	**Under 1 year**	**n**	**%**
Other Specified/Classified	5	20.8	Fall	386	62.5
Unspecified	5	20.8	Other Specified/Classified	62	10.0
Motor vehicle occupant	3	12.5	Unspecified	45	7.3
All other injuries	11	45.8	All other injuries	125	20.2
Total	24	100.0	Total	618	100.0
Average annual rate/100,000	*5.0*		*Average annual rate/100,000*	*129.0*	
1-4 years	**n**	**%**	**1-4 years**	**n**	**%**
Pedestrian	8	29.6	Fall	365	55.5
Fall	5	18.5	Motor vehicle occupant	81	12.3
Struck by/Against	4	14.8	Pedestrian	65	9.9
All other injuries	10	37.0	All other injuries	147	22.3
Total	27	100.0	Total	658	100.0
Average annual rate/100,000	*1.4*		*Average annual rate/100,000*	*34.3*	
5-9 years	**n**	**%**	**5-9 years**	**n**	**%**
Pedestrian	7	36.8	Fall	247	33.2
Motor vehicle occupant	4	21.1	Pedestrian	140	18.8
Fall	3	15.8	Pedal Cyclist	112	15.0
All other injuries	5	26.3	All other injuries	246	33.0
Total	19	100.0	Total	745	100.0
Average annual rate/100,000	*0.8*		*Average annual rate/100,000*	*29.9*	
10-14 years	**n**	**%**	**10-14 years**	**n**	**%**
Motor vehicle occupant	11	31.4	Pedal Cyclist	199	21.8
Pedestrian	8	22.9	Fall	195	21.4
Pedal Cyclist	7	20.0	Pedestrian	142	15.6
All other injuries	9	25.7	All other injuries	242	26.6
Total	35	100.0	Total	778	85.4
Average annual rate/100,000	*1.5*		*Average annual rate/100,000*	*33.1*	
15-19 years	**n**	**%**	**15-19 years**	**n**	**%**
Motor vehicle occupant	105	49.1	Motor vehicle occupant	1,083	56.6
Firearm	65	30.4	Fall	200	10.5
Pedestrian	16	7.5	Struck by/Against	210	11.0
All other injuries	28	13.1	All other injuries	419	21.9
Total	214	100.0	Total	1,912	100.0
Average annual rate/100,000	*8.5*		*Average annual rate/100,000*	*76.1*	

Data Sources: Registry of Vital Records and Statistics, MA Department of Public Health
Massachusetts Hospital Discharge Database, MA Division of Health Care Finance and Policy

FIGURE 16: DISTRIBUTION OF DISCHARGE DISPOSITIONS FOR TRAUMATIC BRAIN INJURY HOSPITALIZATIONS, MA RESIDENTS, 2000



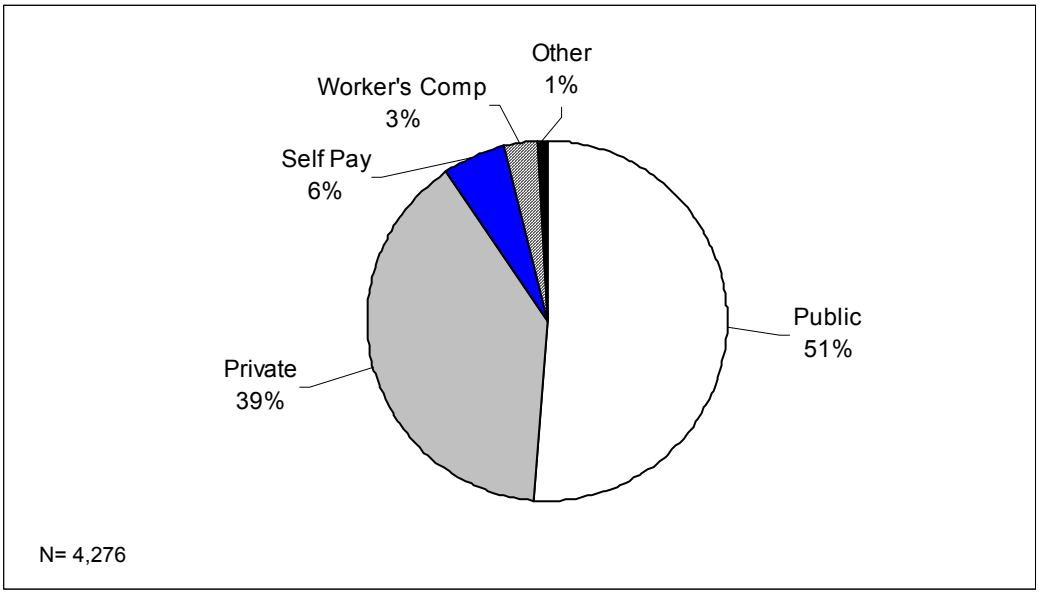
Data Source: Massachusetts Hospital Discharge Database, MA Division of Health Care Finance and Policy
Note: Includes fatal and non-fatal cases

In 2000:

- The majority (62%) of TBI-related hospitalizations were discharged to home and may have required home health services. Another 28% of cases were transferred to a skilled nursing facility or a rehabilitation/chronic hospital. Seven percent (N=311) of those hospitalized for a TBI died in the hospital.

- The average length of stay for a TBI-related hospitalization in 2000 was six days with a median stay of three days.

FIGURE 17: DISTRIBUTION OF PAYER SOURCES FOR TRAUMATIC BRAIN INJURY HOSPITALIZATIONS, MA RESIDENTS, 2000



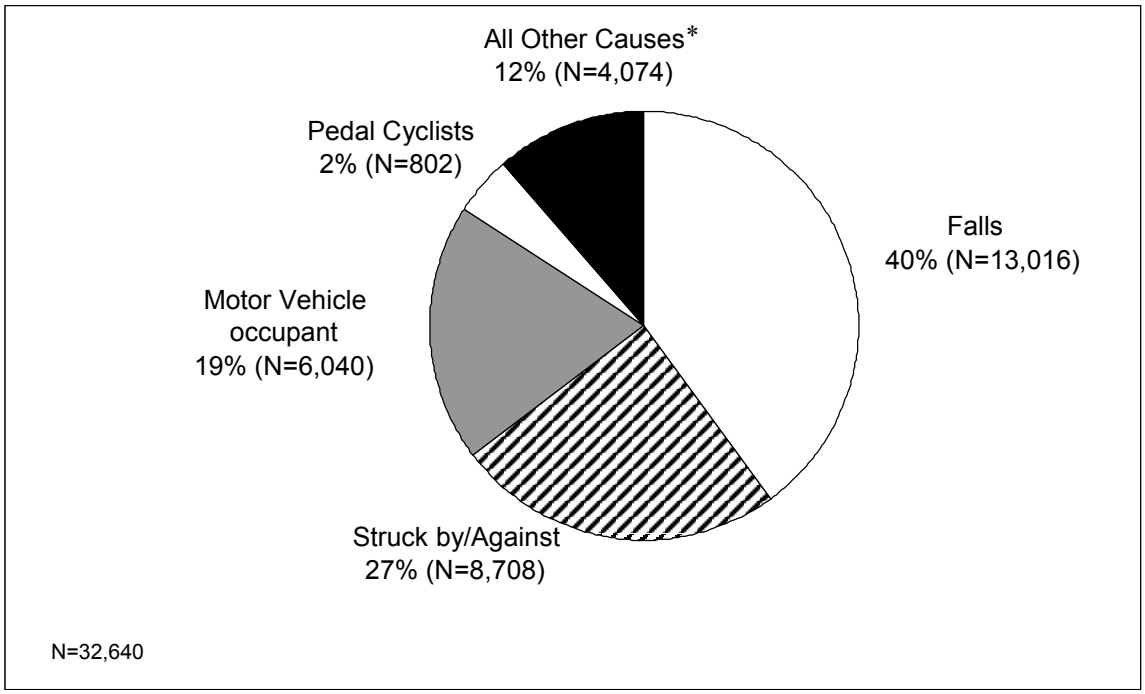
Data Source: Massachusetts Hospital Discharge Database, MA Division of Health Care Finance and Policy
Note: Includes fatal and non-fatal cases

In 2000:

- Total charges for TBI-related hospitalizations for Massachusetts residents were over $102 million.
- More than half of these charges were paid through public sources such as Medicare (36%), Medicaid (11%) and Free Care (3%).

TRAUMATIC BRAIN INJURY-RELATED EMERGENCY DEPARTMENT DISCHARGES

FIGURE 18: NUMBER AND PROPORTION OF LEADING CAUSES OF TBI-RELATED EMERGENCY DEPARTMENT DISCHARGES, MA RESIDENTS, 2002



Data Source: Emergency Department Discharge Database MA Division of Health Care Finance and Policy
* Includes cases for which no external cause was assigned.

- Statewide numbers of emergency department visits for non-fatal traumatic brain injuries were not collected for the time period 1995-2000. However, the newly established Massachusetts Emergency Department Visit Database, administered by the Massachusetts Division of Health Care Finance and Policy, is now collecting statewide data on these visits. Initial analysis of this database indicates that in 2002, there were 32,640 emergency department discharges for TBI among Massachusetts residents (rate of 514/100,000). Falls were the leading cause of TBIs treated and released from EDs. Ninety-one percent of the TBIs treated in the ED in 2002 were unintentional. Males had a higher rate compared to females for TBI-related ED discharges. Black, non-Hispanics had the highest rate of TBI-related visits compared to other race/ethnicity groups (709.0/100,000). Infants under the age of one had the highest rate of TBI-related ED discharges compared to all other age groups (1492.6/100,000).

APPENDICES

APPENDIX A: PREVENTION STRATEGIES

According to the Centers For Disease Control and Prevention (CDC), public health strategies to prevent future TBIs, reduce TBI-related disabilities, and improve outcomes of brain-injured persons include:

- Increasing helmet use during recreation and sports activities (Thurman 1998).
- Preventing falls among children and older adults by modifying the environment to reduce fall hazards and the impact of falls and, where possible, reducing medications with side effects that may contribute to falls (Thurman 2001).
- Enhancing violence-prevention programs designed to decrease the occurrence of self-directed and interpersonal violence (Thurman 2001).
- Improving the use of child safety seats and seat belts and reducing alcohol and drug-impaired driving (Thurman 2001).
- Enhancing trauma care surveillance systems and clinical preventive services (Pollock 2001).
- Improving data collection for TBI incidence (Thurman 1999).
- Conducting follow-up studies of persons with TBI to assess outcomes and identify service needs (Thurman 2001).
- Educating persons with TBI about steps to ease recovery and about available services (Pickelsimer 2002).

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Pickelsimer E, Gu J, Gravelle W, Selassie A, Langlois J. Population-based follow-up of persons with traumatic brain injury: the South Carolina Traumatic Brain Injury Follow-up System. *Brain Injury Source*. Submitted February 2002.

Pollock D, Lowery D. Emergency medicine and public health: new steps in old directions. *Annals of Emergency Medicine* 2001; 38(6):675-83.

Thurman D, Alverson C, Dunn K, Guerrero J, Sniezek J. Traumatic brain injury in the United States: a public health perspective. *Journal of Head Trauma and Rehabilitation* 1999;14(6):602-15.

Thurman D. The epidemiology and economics of head trauma. In: Miller L, Hayes R, editors. *Head Trauma: Basic, Preclinical, and Clinical Directions.* New York (NY): Wiley and Sons; 2001.

Thurman DJ, Branche CM, Sniezek JE. The epidemiology of sports-related traumatic brain injuries in the United States: recent developments. *Journal of Head Trauma and Rehabilitation* 1998; 13(2):1-8.

Source: CDC, National Center for Injury Prevention and Control. *Traumatic Brain Injury Facts,* www.cdc.gov/ncipc/factsheets/tbi.htm

APPENDIX B: PREVENTION RESOURCES

MASSACHUSETTS ORGANIZATIONS

Massachusetts Brain Injury Association (MBIA)

www.mbia.net
484 Main Street #325
Worcester, MA 01608
Phone: (508) 795-0244
Brain Injury Information Line (800) 242-0300

The Massachusetts Brain Injury Association (MBIA) is the leading advocate for assuring that persons who experience brain injuries in the Commonwealth have adequate services to meet their needs. MBIA is responsible for creating and advocating for the Statewide Head Injury Program (SHIP), and Seat Belt Law. The Association also advocates for services for persons with brain injury through Medicaid.

Statewide Head Injury Program (SHIP)

www.state.ma.us/mrc/ship/ship.htm
The Massachusetts Rehabilitation Commission
27 Wormwood Street, Suite 600
Boston, MA 02210-1616
Phone: (617) 204-3600

The Statewide Head Injury Program (SHIP) is part of the Community Services Program of the Massachusetts Rehabilitation Commission. SHIP is the public program in the Commonwealth of Massachusetts that identifies, cultivates and develops resources and services for Massachusetts residents who have sustained an externally caused traumatic brain injury.

Injury Surveillance Program

www.state.ma.us/dph/bhsre/isp/isp.htm
Massachusetts Department of Public Health
2 Boylston Street
Boston, MA 02116
Phone: (617) 988-3314

The Injury Surveillance Program at the Massachusetts Department of Public Health seeks to reduce fatal and nonfatal injuries among Massachusetts residents by monitoring the incidence, trends, risk factors and circumstances of these injuries and disseminating this information to injury prevention advocates. These data may be used to inform decisions regarding the development and evaluation of injury prevention initiatives and policies.

Injury Prevention and Control Program

www.state.ma.us/dph/fch/injury/index.htm
Massachusetts Department of Public Health
250 Washington Street
Boston, MA 02108
Phone: (617) 624-5070

The mission of the Injury Prevention and Control Program is to reduce the rates of injuries at home, on the move, in the community, at schools, at play, and to improve emergency medical services for children. The program serves communities, groups, and individuals by offering: training and health education, technical assistance, data analysis and reports, coalition and task force leadership, program development assistance, and public information materials.

NATIONAL ORGANIZATIONS

Brain Injury Association of America

www.biausa.org
105 North Alfred Street
Alexandria, VA 22314
Phone: (800) 444-6443

The Brain Injury Association of America (BIAA) identifies and responds to the needs of individuals with brain injury and their families. It creates new and innovative programs to serve its constituencies. BIAA has state-chartered affiliates, to help injured persons. BIAA also has a number of fact sheets about TBI.

National SAFE KIDS Campaign

www.safekids.org
1301 Pennsylvania Ave, NW Suite 1000
Washington, DC 20004
Phone: (202) 662-0600

The National SAFE KIDS Campaign is the first and only national organization dedicated solely to the prevention of unintentional childhood injury, the number one killer of children 14 years and under.

ThinkFirst National Injury Prevention Foundation

www.thinkfirst.org
5550 Meadowbrook Drive, Suite 110
Rolling Meadows, IL 60008
Phone: (847) 290-8600

ThinkFirst Foundation works to prevent brain, spinal cord, and other traumatic injuries by educating individuals, community leaders, and policy makers.

National Bicycle Safety Network

www.cdc.gov/ncipc/bike/

The National Bike Safety Network (NBSN) works to coordinate efforts among government, private, non-profit, and research organizations to reduce the number of bicycle injuries. It promotes bicycle safety through public education, information-sharing among member organizations, and appropriate environmental changes.

National Highway Traffic Safety Administration

www.nhtsa.dot.gov
Child Passenger Safety: www.nhtsa.dot.gov/people/injury/childps
Phone: (888) 326-4236

The National Highway Traffic Safety Administration (NHTSA) is responsible for reducing deaths, injuries, and economic losses resulting from motor vehicle crashes. NHTSA provides consumer information about motor vehicle safety topics.

National Institute of Neurological Disorders and Stroke
www.ninds.nih.gov
National Institutes of Health Neurological Institute
P.O. Box 5801
Bethesda, MD 20824
Phone: (800) 352-9424
National Institute of Neurological Disorders and Stroke's (NINDS) mission is to reduce the burden of neurological disease---a burden borne by every age group, by every segment of society, by people all over the world.

National Association of State Head Injury Administrators (NASHIA)
www.nashia.org
4330 East West Highway, Suite 301
Bethesda, MD 20814
Phone: (301) 656-3500
An organization whose mission is to assist state government in promoting partnerships and building systems to meet the needs of individuals with brain injury and their families.

Content Source: National Center for Injury Prevention and Control. *Traumatic Brain Injury Fact Sheet.*

APPENDIX C: NOTES AND METHODOLOGY

DATA SOURCES:

Primary sources:

Mortality (Death) Data: 1995-2000
Registry of Vital Records and Statistics, Massachusetts Department of Public Health. Death files are based on a calendar year (January 1 – December 31).

Massachusetts Hospital Discharge Database (MHDD): 1995-2000
Center for Health Information, Statistics, Research & Evaluation, Massachusetts Division of Health Care Finance and Policy. Hospital discharge data files are based on a fiscal year (October 1 – September 30).

Other sources:

Massachusetts Emergency Department Discharge Database: 2002
Center for Health Information, Statistics, Research & Evaluation, Massachusetts Division of Health Care Finance and Policy. Emergency department discharge files are based on a fiscal year (October 1 – September 30). Statewide data collection of ED discharges beginning fiscal year 2002.

Massachusetts Outpatient Observation Stay Database: 2000
Center for Health Information, Statistics, Research & Evaluation, Massachusetts Division of Health Care Finance and Policy. Outpatient observation discharge files are based on a fiscal year (October 1 – September 30). A general definition of Outpatient Observation services is defined for reporting purposes in the Case Mix Regulation 114.1 CMR 17.02 as: *Observation services are those furnished on a hospital's premises which are reasonable and necessary to further evaluate a patient's condition and provide treatment to determine the need for possible admission to the hospital. These services include the use of a bed and periodic monitoring by a hospital's physician, nursing and other staff.*

Population Estimates:
1995-1998 population estimates: Population estimates computed by the Massachusetts Institute for Social and Economic Research (MISER) were used to calculate rates in this report. 1998 MISER population estimates were used to calculate average annual rates.
1999 population estimates: Preliminary Draft Allocation and Interpolation of Census 2000 SF1 File and Massachusetts Institute for Social and

Economic Research 1998 Population Estimate File. Massachusetts Department of Public Health, Bureau of Health Statistics, Research and Evaluation, Division of Research and Epidemiology.
2000 population: Population computed by the United States Census Bureau.

TRAUMATIC BRAIN INJURY DEFINITION:

A TBI is defined as an occurrence of injury to the head (arising from blunt or penetrating trauma or from acceleration-deceleration forces) that is associated with any of these symptoms or signs attributable to the injury: decreased level of consciousness, amnesia, other neurologic or neuropsychologic abnormalities, skull fracture, diagnosed intracranial lesions, or death. Exclusions include: 1) lacerations or contusions limited to the eye, ear, face or scalp; 2) birth trauma; 3) primary anoxic, inflammatory, infectious, toxic, or metabolic encephalopathies that are not complications of head trauma; 4) tumors; and 5) brain infarction (ischemic stroke) and intracranial hemorrhage (hemorrhagic stroke) without associated trauma. (www.stipda.org/resol/99nphss-tbi.htm).

The following International Classification of Disease codes were used to identify a TBI:

Mortality:
For surveillance years 1995 to 1998:
ICD-9 codes 800-801 (.0-.9), 803-804(.0-.9), 850.0-854.1, 873(.0-.9), 905.0 and 907.0 in any mentionable condition field.
For surveillance years 1999 to 2000:
ICD-10 codes S01(.0-.9), S02(.0,.1,.3,.7,.8,.9), S06(.0-.9), S07(.0,.1,.8,.9), S09(.7-.9), T01.0,T02.0,T04.0,T06.0,T90(.1,.2,.4,.5,.8,.9) in any mentionable condition field.
Morbidity:
ICD-9 CM codes 800-801(.0-.9), 803-804(.0-.9), 850.0-854.1 and 959.01 in any primary or associated diagnosis code field.
Persons who died during admission or who were transferred to another hospital were excluded from the analysis unless otherwise stated.

INJURY CLASSIFICATIONS:

General notes:

Injuries are classified using multiple parameters. For example, an injury may be classified by a diagnosis (e.g. a fracture) or by the mechanism, or external cause of the injury (e.g. a fall). Injuries are also classified by intent: unintentional injuries ("accidents") and intentional injuries (assaults/homicides or self-inflicted/suicides).

In this report injuries are classified by their external cause and intent according to the International Classification of Diseases (ICD) manual.

However, eight percent of TBI fatalities and between 3-4 % of hospital and ED discharged cases in this report had no external cause code listed. In 1999 the revised ICD manual (ICD-10) was implemented for mortality data. Certain injury categories may not be comparable between ICD-9 (the previous version) and ICD-10. A listing of ICD-9 external causes of injury with examples can be found in the Appendix. A modified version of the *Matrix of E-code Groupings for Presenting Injury Mortality and Morbidity Data*, developed by the CDC, was used to group injury causes. However, re-classification was done on certain injuries. Pedestrian [E800-807(.2),E810-825(.7), E826-829(.0)] and Pedal Cyclist [E800-807(.3),E810-825(.6),E826(.1,.9), E827-829(.1)] injuries in this report include cases that may or may not have involved a motor vehicle. Motor vehicle occupant cases in this report include unspecified MV cases [E810-819 (.0-.5,.8-.9)].

This report is restricted to traumatic brain injury diagnoses and examines all external causes and intents of these injuries.

RATES:

Age-Specific Rate:

A rate for a specified age group was calculated by dividing the actual number of cases in a given year for a specific age group by the population in that age group for that year. The numerator and the denominator refer to the same age group.

$$\text{Age-specific rate (ages 25-34)} = \frac{\text{\# of cases among residents ages 25-34 in a given year}}{\text{population of residents ages 25-34 in that year}} \times 100{,}000$$

Average Annual Rate:

An average annual rate is used when combining multiple years of data. To calculate the average annual rate for injuries among Massachusetts residents, the total number of injuries for the specified time period are averaged, the total population for the specified time period are averaged. The numerator and the denominator refer to the same time period studied.

$$\text{Average Annual rate} = \frac{\text{\# of cases among residents during time period studied divided by \# of years studied}}{\text{sum of resident population during time period studied divided by \# of years studied (1998 MISER population estimate)}} \times 100{,}000$$

Crude Rate:

The rate is an estimate of the proportion of a population that died or were injured during the year. The numerator is the number of persons who died or were injured during the year and the denominator is the size of the population.

$$\text{Crude rate} = \frac{\text{\# of resident injury deaths (or non-fatal injuries) in a year}}{\text{\# of residents}} \times 100{,}000$$

APPENDIX D: DATA TABLES

TABLE 1-A. MEAN ANNUAL FREQUENCY AND AVERAGE RATE FOR TBI-RELATED FATALITIES BY SEX AND AGE GROUP, MA 1995-2000

Characteristic	MAF[1]	1998 Population	Rate[2]
Both sexes			
All ages	544	6,291,263	8.6
under 1 year	4	79,860	--[3]
1-4 years	5	320,000	1.4
5-9 years	3	414,810	--[3]
10-14 years	6	391,860	1.5
15-19 years	36	418,478	8.5
20-24 years	39	465,352	8.3
25-34 years	67	1,005,337	6.7
35-44 years	61	1,019,365	6.0
45-54 years	49	818,660	6.0
55-64 years	44	495,555	9.1
65-74 years	56	442,003	12.7
75-84 years	90	299,482	30.1
85+ years	85	120,501	70.4
Female			
All ages	168	3,251,299	5.2
under 1 year	2	38,907	--[3]
1-4 years	1	155,970	--[3]
5-9 years	1	202,327	--[3]
10-14 years	2	190,919	--[3]
15-19 years	9	207,452	4.3
20-24 years	9	234,466	3.7
25-34 years	13	502,881	2.6
35-44 years	11	516,010	2.1
45-54 years	10	420,102	2.4
55-64 years	9	258,746	3.3
65-74 years	18	246,634	7.3
75-84 years	38	187,831	20.1
85+ years	46	89,054	51.3
Male			
All ages	376	3,039,964	12.5
under 1 year	2	40,953	--[3]
1-4 years	3	164,030	--[3]
5-9 years	2	212,483	--[3]
10-14 years	4	200,941	--[3]
15-19 years	27	211,026	12.6
20-24 years	30	230,886	12.9
25-34 years	54	502,456	10.7
35-44 years	50	503,355	10.0
45-54 years	39	398,558	9.7
55-64 years	36	236,809	15.1
65-74 years	38	195,369	19.5
75-84 years	52	111,651	46.9
85+ years	39	31,447	124.5

[1] Mean annual frequency. MAF columns may not add up to total due to rounding.[2]Rate= (MAF/Population) x100,000. Caution: Rates calculated on frequencies < 20 may be unstable and therefore should be interpreted with caution. [3]Calculations based on fewer than 5 events are excluded.

TABLE 1-B. MEAN ANNUAL FREQUENCY AND AVERAGE RATE FOR NON-FATAL TBI-RELATED HOSPITAL DISCHARGES BY SEX AND AGE GROUP, MA, 1995-2000

Characteristic	MAF[1]	1998 Population	Rate[2]
Both sexes			
All ages	3,752	6,291,263	59.6
under 1 year	103	79,860	129.0
1-4 years	110	320,000	34.3
5-9 years	124	414,810	29.9
10-14 years	152	391,860	38.7
15-19 years	319	418,478	76.1
20-24 years	252	465,352	54.1
25-34 years	426	1,005,337	42.3
35-44 years	419	1,019,365	41.1
45-54 years	318	818,660	38.9
55-64 years	248	495,555	50.0
65-74 years	353	442,003	79.8
75-84 years	534	299,482	178.2
85+ years	397	120,501	328.9
Female			
All ages	1,488	3,251,299	45.8
under 1 year	44	38,907	112.2
1-4 years	41	155,970	26.2
5-9 years	38	202,327	18.5
10-14 years	44	190,919	22.8
15-19 years	89	207,452	43.0
20-24 years	62	234,466	26.2
25-34 years	108	502,881	21.4
35-44 years	116	516,010	22.4
45-54 years	98	420,102	23.4
55-64 years	89	258,746	34.3
65-74 years	169	246,634	68.5
75-84 years	311	187,831	165.8
85+ years	281	89,054	315.9
Male			
All ages	2264	3,039,964	74.5
under 1 year	59	40,953	144.9
1-4 years	69	164,030	42.0
5-9 years	87	212,483	40.8
10-14 years	108	200,941	53.9
15-19 years	230	211,026	108.8
20-24 years	190	230,886	82.4
25-34 years	318	502,456	63.3
35-44 years	303	503,355	60.2
45-54 years	220	398,558	55.2
55-64 years	159	236,809	67.2
65-74 years	184	195,369	93.9
75-84 years	222	111,651	199.1
85+ years	115	31,447	365.7

[1] Mean annual frequency. MAF columns may not add up to total due to rounding.[2]Rate= (MAF/Population) x 100,000.

TABLE 2-A. FREQUENCY AND AVERAGE ANNUAL RATE FOR TBI FATALITIES BY RACE/ETHNICITY AND SEX, MA, 1995-2000

	White non-Hispanic		Black non-Hispanic		Hispanic		Asian/Pacific Islander	
Year	Male N	Female N	Male N	Female N	Male N	Female N	Male N	Female N
1995	308	135	28	9	27	6	11	2
1996	328	130	21	9	15	7	6	1
1997	317	150	27	9	20	3	5	3
1998	329	159	31	5	22	2	5	2
1999	327	167	23	5	24	5	8	2
2000	306	175	17	4	21	5	11	6
Total	1,915	916	147	41	129	28	46	16
MAF[1]	**319**	**153**	**25**	**7**	**22**	**5**	**8**	**3**
Rate[2]	12.3	5.5	18.0	4.7[3]	12.3	2.6[3]	8.7[3]	--[4]

[1] Mean Annual Frequency
[2] Rate= (MAF/1998 population) x 100,000
[3] Rates calculated on frequencies < than 20 may be unstable and should be interpreted with caution.
[4] Calculations based on fewer than 5 events are excluded.

TABLE 2-B. FREQUENCY AND AVERAGE ANNUAL RATE FOR NON-FATAL TBI-RELATED HOSPITAL DISCHARGES BY RACE/ETHNICITY AND SEX, MA, 1995-2000

	White non-Hispanic		Black non-Hispanic		Hispanic		Asian/Pacific Islander	
Year	Male N	Female N	Male N	Female N	Male N	Female N	Male N	Female N
1995	1,800	1,204	164	53	151	54	33	15
1996	1,653	1,177	133	48	105	58	33	21
1997	1,700	1,257	159	53	157	41	30	20
1998	1,735	1,264	155	64	176	67	22	23
1999	1,722	1,252	144	70	174	54	36	22
2000	1,768	1,373	150	59	182	68	45	17
Total	10,378	7,527	905	347	945	342	199	118
MAF[1]	**1,730**	**1,255**	**151**	**58**	**158**	**57**	**33**	**20**
Rate[2]	66.6	44.8	111.0	40.1	90.0	32.1	37.6	22.2

[1] Mean Annual Frequency
[2] Average Annual Rate= (MAF/1998 population) x 100,000

TABLE 3-A. MEAN AVERAGE FREQUENCY AND PROPORTION OF TBI-RELATED FATALITIES BY METHOD AND SEX, MA, 1995-2000

	Males		Females		Total	
Method	MAF[1]	Percent[2]	MAF	Percent	MAF	Percent
Firearms	126	33.4	16	9.2	141	25.9
Falls	72	19.1	49	29.3	121	22.2
MV Occupant	60	16.0	27	16.2	88	16.2
Pedestrian	17	4.4	10	5.7	26	4.8
Unspecified	48	12.6	35	20.9	83	15.3
All Other Causes	54	14.4	31	18.6	85	15.6
TOTAL	376	100.0	168	100.0	544	100.0

[1] Mean Annual Frequency
[2] Percent of total column may not add up to 100 due to rounding

TABLE 3-B. MEAN AVERAGE FREQUENCY AND PROPORTION OF NON-FATAL TBI-RELATED HOSPITALIZATIONS BY METHOD AND SEX, MA, 1995-2000

	Males		Females		Total	
Method	MAF[1]	Percent[2]	MAF	Percent	MAF	Percent
Falls	846	37.4	796	53.5	1642	43.8
MV Occupant	643	28.4	385	25.9	1030	27.5
Struck By	221	9.7	45	3.0	266	7.1
Pedestrian	137	6.1	93	6.2	230	6.1
Pedal Cyclist	112	4.9	25	1.7	137	3.7
Unspecified	78	3.4	20	1.3	61	1.6
All Other Causes	227	10.0	124	8.4	387	10.3
TOTAL	2,264	100.0	1,488	100.0	3,752	100.0

[1] Mean Annual Frequency
[2] Percent of total column may not add up to 100 due to rounding

TABLE 4-A. ANNUAL TRENDS IN TBI-RELATED FATALITIES BY LEADING METHODS , MA, 1995-2000

Method	1995	1996	1997	1998	1999	2000
Firearms	158	147	137	159	124	122
Falls	95	98	118	131	150	135
MV Occupant	77	84	100	94	79	92
Pedestrian	31	26	28	17	30	24

TABLE 4-B. ANNUAL TRENDS IN NON-FATAL TBI-RELATED HOSPITAL DISCHARGES BY LEADING METHODS, MA, 1995-2000

Method	1995	1996	1997	1998	1999	2000
Falls	1,500	1,454	1,624	1,667	1,656	1,950
MV Occupant	1,101	932	1,107	1,074	952	1,014
Struck By/Against	276	280	275	263	221	280
Pedestrian	262	246	239	208	201	224